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FIG. 1.—THE NEW FRANKFORT AUTOMOBILE FIRE ENGINE AT WORK.

A GERMAN AUTOMOBILE FIRE ENGINE.

A GERMAN AUTOMOBILE FIRE ENGINE.

SOME INTERESTING EXPERIMENTS IN FRANKFORT.

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN

The methods of fire brigades are undergoing a thorough revolution, due to the introduction of motor-propelled vehicles. Owing to the great advantages of automobiles, especially in fire service, all the larger German fire brigades are adopting motor-propelled cars. Experience has shown these cars to be far more economical in operation than horse-drawn vehicles, apart from the fact that they are always ready for immediate operation.

Extremely instructive tests have recently been made by the Frankfort-on-the-Main fire brigade, with an automobile fire engine constructed on a novel system by the Daimler Motor Company in conjunction with Messrs. G. Schiele & Co. The constructive features of this vehicle are as follows:

The chassis is a standard 3-ton Daimler chassis, conveniently altered with a view to its special service, and designed for an effective load of 1½ tons. It is equipped with a 4-cylinder motor, yielding at a speed of 950 R. P. M. about 41 horse-power on the brake, which imparts to the car a speed of 21 miles an hour, allowing gradients up to 10 per cent to be negotiated. When the car is stopped, the same motor operates the high-pressure turbine pump, mounted on the chassis immediately behind the driver's seat.

The chassis is made of compressed-steel sheet girders with compressed transversal beams and lateral shields, the fore and rear axles, as well as the axle legs, being of special nickel steel. All the more vital parts, which have to transmit considerable amounts of energy, are made of special nickel steel, while the gear wheels are made of case-hardened chrome-nickel steel, the gear box of cast iron, and the differential gear case of cast steel. The carbureter allows both gasoline and benzol to be used as fuel with the same degree of safety, and without any alteration, the consumption with full load being about 24 pounds per hour. The ignition is by magneto, with auxiliary battery ignition. The motor is lubricated automatically from a pump, which supplies the oil under pressure to the three main bearings of the crankshaft. From these bearings, it enters the hollow crankshaft and flows into the piston-rod bearings, into the piston, and dropping from the piston bottom, arrives at the hollow piston bolt. Any unused oil serves to lubricate the piston and cylinder. This arrangement dispenses with piping, and reduces the oil consumption to about 2 pounds with a journey of 100 miles.

The gasoline and benzol tanks, of about 42 quarts each, are so designed as to leave, after about one hour's journey, sufficient fuel for another six hours.

The radiator is a reinforced Mercedes beehive radiator, the cooling water being thrown by a pump operated from the motor through the various compartments of the latter, after again reaching its normal temperature on passing through the radiator.

The gear box is coupled with the motor through a removable friction clutch, and allows of four forward speeds and one backward speed. From the gear box a shaft, located in universal joints, leads to the rear axle drive, and by means of two couples of conic wheels, operates the differential shafts, at the end of which are mounted bronze pinions engaging in the rear wheel toothed rims, and thus effecting the propulsion of the car. The differential case is located on resilient thrust beams, dealing with any sudden or violent shocks.

The steering device consists of a hand wheel, a steering axle with worm and worm segment, and drawbars, guiding axles, and levers, acting on the fore wheels.

The chassis is equipped with three self-contained brakes, viz.: a pedal brake, acting on the differential shaft; a pedal brake, acting on the gearing shaft; and a hand lever brake, acting on the rear wheels.

The pump is operated from the upper gear shaft through a gear wheel and claw clutch. The gear wheel is perfectly inclosed, and runs in an oil bath. A convenient lever arrangement enables the centrifugal pump to be thrown in after the car has arrived at the spot, an ingenious arrangement allowing the circulation cocks to be so shifted as to effect the cooling water circulation during the operation of the high-pressure pump from the latter, which, even in the case of strained permanent operation, insures an adequate cooling.

The pump, operated at its normal speed through gearing, is a multiple-stage high-pressure centrifugal pump of the latest design, with hydraulically balanced shaft, able to supply about 400 gallons per minute to a height of about 200 feet. A water tank of about 70 gallons capacity insures immediate readiness for operation and a safe and easy suction. As the connecting tube is located at the lowermost point of the tank, the whole of its capacity can be utilized for the pump, thus enabling the latter to project a jet of about ¼ of an inch in diameter and 38 to 50 feet in height during eight minutes. This is why no gas-operated reserve fire engine is required.

The tests made by the Frankfort-on-the-Main fire brigade have shown this motor and pump to work with excellent results, in regard to the suction and pressure effects and the safety of operation in the case of permanent service. The most remarkable fact is that the pump draws in water from the river Main up to a depth of 23 feet. The widespread opinion that centrifugal pumps would be notably inferior in their suction effects to reciprocating pumps, was thus shown to be entirely erroneous. Both with one and two jets, a height of up to 160 feet was covered, while tests on the hydrant with one or two jets of ¾ inch diameter showed a height of up to 110 feet to be reached with 75 pounds pressure, with one jet of 1 inch diameter, up to 102 feet, and with eight jets of ¼ inch diameter, up to 75 or 78 feet (See Fig. 1). These remarkable results could hardly be exceeded by any steam-operated fire engine, while with a larger water supply, considerably better results would be reached.

Immediately after the car has arrived at the fire, with a speed of upward of 20 miles, a rapid operation of the levers is sufficient to get the pump into working order, raising water from the reserve tank during eight minutes. As the connection to a hydrant or to a suction pipe on the river can be established in the meantime, the pump is able to insure an uninterrupted service with up to eight jets. In fact, the fuel tanks are designed for keeping such a service up during seven to eight hours.

Fire-engine trains on the novel system will consist of only two vehicles, viz., a fire-engine car, as above described, in the place of steam and gas fire engines, and a car for the men and accessories, in addition to a fire-ladder car.

Another type of automobile fire engine recently adopted by the Hamburg Fire Brigade is the electromobile hauling car, represented in Fig. 2. This is equipped with Daimler electric motors mounted directly on the wheels, the steering pivot being situated above the point of contact between the wheel and the ground, thus avoiding any risk of the driver losing control of the car in case the current supply should be discontinued, as no critical momentum can arise.

The warranted normal output of the electric motors is 12 horse-power with a tension of 160 volts between terminals (the charging tension being 220 volts) and a speed rotation of 170 R. P. M. They are able to impart to the vehicle mounted in working order, with its full load (its total weight, inclusive of two men, being 3 tons) a maximum speed of 20 to 35 miles on the level, while allowing maximum gradients of 12 per cent to be dealt with on macadamized roads.

FIG. 2.—THE ELECTRICAL TRACTION AUTOMOBILE FOR FIRE SERVICE.

A GERMAN AUTOMOBILE FIRE ENGINE.

INFLUENCE OF THE DEPTH OF WATER ON THE SPEED OF SHIPS.

At the great speeds now attained by steamships the influence of the depth of water cannot be neglected. In order to determine the extent of this influence, the British Admiralty has conducted two series of experiments with the destroyer "Cossack." The depth of water at low tide was about 45 feet in one series and 240 feet in the other. In each series the speed varied from 17 to 34½ knots. The draft, water line and displacement, when the vessel was at rest, were practically the same in both cases. The torque of the shafts was measured with the Bevis-Gibson torsiometer and the number of revolutions was accurately determined. The variations in the inclination of the axis of the vessel were measured with a water level 20 feet long. The following conclusions were deduced:

Up to a critical speed, which varies with the vessel and with the depth of water and which was 21 knots for the "Cossack" in the shallower water, the number of revolutions, the power consumed, and the dip of the axis increase, with increasing speed, more rapidly in shallow than in deep water. At the critical speed the vessel begins to mount the wave of displacement. As the speed is still increased, the dip, power consumed, and number of revolutions increase very slowly and tend to become equal in shallow and in deep water. In the experiments with the "Cossack," this equality was attained at a speed of 26 knots. At still higher speeds the power consumed, number of revolutions, and dip were slightly less in shallow than in deep water. It was calculated that, for this vessel, the influence of the bottom would vanish at a depth of about 200 feet.

Experiments made in Denmark with a torpedo boat of 105 tons displacement and a maximum speed of 20 knots gave critical speeds of 12 knots for a depth of 12 feet, and 15 knots for 20 feet. The influence of the bottom was barely perceptible at 53 feet.

Lanbeuf has drawn attention to the bearing of these results on speed trials. For torpedo boats and destroyers of 20 to 34 knots the minimum depth at which the influence of the bottom becomes negligible varies from 53 to 92 feet. At Cherbourg, where the speed trials of many French torpedo boats and destroyers are conducted, the depth of water at low tide is between 43 and 53 feet. Hence the results of these trials are uncertain, and they may be either too high or too low, as the critical speeds of these vessels are not known. It is probable, however, that the speeds deduced from the trials are too low for the torpedo boats of 100 tons and too high for the destroyers of 28 and 30 knots.—Cosmos.

THE INTERNAL-COMBUSTION ENGINE.—I.*

RECENT IMPROVEMENTS.

BY H. E. WIMPERIS.

A survey of the progress made during the last twenty-five years in almost any field of engineering work would show an immense advance. Even during the past ten years very considerable progress has been made in certain branches of applied science, and in none of them to a greater extent than in the internal-combustion engine. We need not in this comparison claim the gun as a form of internal-combustion engine, though we are naturally entitled to do so. We may leave lethal weapons aside, and think only of the remarkable development of the reciprocating internal-combustion engine, and of the many changes it has brought about in our times. It has revolutionized cross-country transit. It has given us the long-deferred, but now actually achieved, victory called the "conquest of the air." It is extraordinary to think of the numbers of men who have spent ingenious years in seeking a solution of the problem of flight. The solution has come in the unexpected form of a pair of long, sail-like arms, driven forward by small high-speed internal-combustion engine. This simple form of design, which, owing to the relation between center of pressure and angle of tilt, seems to be naturally stable, bids fair to be adopted in a great output of flying machines shortly to be constructed. The hardly less novel, but less interesting, dirigible balloon owes the whole of its dirigibility, whatever that may amount to, to the internal-combustion engine.

Less startling, but of considerable material importance, is the utilization of "waste heat" in our coal- and iron-producing areas. Our coal supply is admitted to be limited, and there seems to be at least an indication that at the present rate of consumption mankind would, in a few centuries, have to be prepared to turn its attention to the unlocking of some other form of stored-up energy, perhaps a radio-active one. It is not too much to say, however, that if the power available from the waste gases of blast-furnaces and coke-ovens in this country—and the amount can hardly be less in the aggregate than 1,000,000 horse-power—were put to use, the saving in the coal consumption might perhaps give us another half century or two in which to look about for some substitute for coal.

In writing of what has been already achieved, we have to remember that we are only yet at an intermediate stage in the development of the internal-combustion engine. The internal-combustion engine gives us a bigger return for heat put in than any other form of engine. We cannot imagine the development of the future "going back," so to speak, on such an advance as that. The internal-combustion engine must come, and existing steam engines be replaced. This means the supersession of the steam turbine, and may therefore seem to suggest a retrograde step, since the rotary engine is mechanically an improvement on the reciprocating one. We have to remember, however, that evolutionary processes sometimes take a step backward to an earlier form in bringing forward the latest and most developed creation. No one would look on any reciprocating engine as a final improvement on a rotary one, even though, as is now the case, large gas engines are capable of so uniform a rotary motion that alternators are easily driven by them in parallel—the standard test of excellence in this respect. The day of the gas-engine turbine must come. Numbers of men are working at the problem which it presents; but little has as yet been published as to the result of their labors—an indication that the many difficulties are not yet mastered.

The present stage in the development of the internal-combustion engine is a convenient one at which to summarize briefly what has been done in regard to its improvement. We therefore propose in this and the succeeding articles of the series to state the problem and the lines on which, with such a striking measure of success, its solution has been attempted.

The problem can be stated in a very simple form. Given one pound of carbon of, say, 12,000,000 foot-pounds calorific value, which is a normal estimate, find how to obtain the largest possible amount of useful power. So far this energy has always been liberated in the form of heat. This heat has been given to some body which, by its subsequent cooling, can give out mechanical energy—such a body is a mass of gas or vapor.

Let us assume that a mass of gas has been chosen as the working medium. It is obviously desirable that the heat liberated should be absorbed as completely as possible by the gas, but in investigating whether this has been effected one at once meets with a check. To tell whether the whole of the 12,000,000 foot-pounds of heat energy has reached the gas, we may either look out for possible chances of heat leakage or may measure the amount of energy in the gas at the end of the operation. But to do the latter is practically impossible, for we do not know the specific heat at high temperature of any gas, and to do the former is extremely difficult, owing to the very short time the heat transference usually takes, and owing also to our lack of knowledge as to the temperature of metal or other surfaces in contact with, and inclosing, the gas. Many attempts have been made to ascertain what happens to the heat liberated, and much has been written on such topics as "dissociation," "after-burning," and "increasing specific heats." There would be no difficulty in filling the whole of the allotted space with a discussion of the various experiments that have been made and theories that have been built on this subject, but as many other matters have also to be dealt with, and as the author has already written on this topic elsewhere,* he does not now propose to go into the matter at length.

Briefly summarized, the result of gas-engine experiment is to establish that only about 50 to 55 per cent of the heat energy known to be liberated is accounted for by multiplying the measured rise of temperature by the commonly accepted figure for the specific heat at constant volume. The same ratio of 50 to 55 per cent was found for all sizes and shapes of containing vessel, and for all mixtures of gas. This constancy at once disposed of the theory that the "suppression of heat" was due to dissociation, as such an effect would naturally be dependent upon, and increase with, the increasing temperatures due to the richer mixtures. Equally it showed that the cooling of the gas by convection currents, radiation, and conduction to the walls of the containing vessel was an inadequate explanation. The suggestion of the French physicists, MM. Mallard and Le Chatelier, that the effect must be due to increase of specific heat with temperature was open to precisely the same objection as that of dissociation, and involved values of the instantaneous specific heat much in advance of what was then thought likely. It is now generally recognized that the real explanation of the apparent suppression of energy is due to a combined cooling effect and rise of specific heat. "After-burning" is now generally believed, as a result of many tests, not to occur in normal circumstances. With a weak mixture the time of explosion, and therefore of cooling, is a long one, so that the cooling loss has time to become considerable, and this compensates for the lesser degree to which the theory of increasing specific heats is effective for these weak mixtures and low temperatures.

The constancy of this apparent "loss" made it clear that no great improvement in the internal-combustion engine could be looked for in any increase of pressure and temperature in a gaseous mixture of given strength. We cannot alter the specific heat law of a substance. We might, perhaps, alter our working medium, which now for the most part is nitrogen, but no other gas is so cheap or so easily obtained; but we may vary the part of the temperature scale over which we work, and, within limits, we may affect the cooling loss by altering the shape of the containing vessel or cylinder. Experiments have shown that the less the ratio of cooling surface to volume the less the proportionate cooling loss, and therefore the greater the amount of thermal energy converted into work.

Engines that have "pockets," that is, cavities in their walls, in which to contain ignition plugs or valves, are known to be less efficient than those that have not. On the other hand, it must not be forgotten that although this loss of efficiency exists, it is at any rate partly compensated for by the greater flexibility of the engines, that "pockets" have a very useful effect in enabling very variable mixtures to fire. The ignition plug is placed in a pocket so that, even when the mixture is a very poor one, there will be sufficient local "richness" in its neighborhood to start an explosion which, once started, proceeds throughout the mass of the gas. Another fact which may have the result of increasing "pocketing" is the recently measured temperature limit for pre-ignition. Prof. Hopkinson has found that surfaces below 700 deg. C. will not cause pre-ignition, while those above may do so—if above 750 deg. C. they are pretty sure to do so. Now the surfaces most likely to rise to such temperatures are those remote from the cooling water in the jacket. The projecting end of an ignition plug is such a surface, and when exposed to the full heat of the explosion, as it is when the plug is not pocketed, pre-ignition may well occur. Prof. Hopkinson has shown also that when once a point of metal gets hot enough to cause pre-ignition, the very ignition of the flame in its neighborhood will tend to cause the temperature to rise still higher, so that the phenomenon grows on itself and persists. It is not everyone who is moved, however, by such considerations, and we have lately seen in the design of the new Daimler engine a clearly-expressed intention to avoid pocketing and its consequent loss of efficiency without any apparent fear of introducing other features much less desirable. It is only fair to say, however, that this engine is still on its trial. The ideal plan would appear to be to pocket the ignition plug but not the valves, and so combine the good features of both systems.

This frank abandonment of the highest possible efficiency by those who use pocketed engines brings us naturally to the consideration of thermal efficiency and the laws that regulate it. One may say at once that the theory of the internal-combustion engine has, until lately, been in a chaotic condition. The standard of efficiency for gas engines laid down by an influential committee has been found subsequently to be unsatisfactory as giving an impossibly ideal figure. That such remarkable progress in invention and mechanical perfection should have gone on side by side with this uncertainty as to the true standard of performance has often struck observers with astonishment. The considerable scale of the practical side of gas-engine development is illustrated by the fact that of one well-known make of double-acting gas engines alone, no fewer than 247 engines of an aggregate output of 308,000 brake horse-power have been built or ordered during the last six years. This corresponds to the large figure of more than 50,000 brake horse-power per year for only one of the many firms engaged on the work. At the moment the total capacity of gas engines in use must be well over 2,000,000 horse-power, and of gasoline engines much more than 1,000,000 horse-power, making a total of more than 3,000,000 horse-power in internal-combustion engines. These are striking figures. Some of these engines and plants work with solid fuel and some with liquid. It would not be possible, even were it considered desirable, to use liquid fuel to the entire exclusion of any other The present output of petroleum over the whole world is only 20,000,000 tons, a very small figure compared with the yearly consumption of 800,000,000 tons of coal. Unless, therefore, fresh supplies of oil are discovered, there can be no development of the internal-combustion engine which would lead to liquid fuel replacing solid fuel altogether.

In the articles that will follow, the author intends to deal with the problem of efficiency, taking into account the now established increase of specific heat with temperature, its effect on rating, and the recent practical improvements in the design and operation of gas engines and gas-producing plants.

(To be continued.)

* Nature.

* "The Internal-Combustion Engine." (Constable & Co.)

In making the calculations involved in the design of ice machines of the absorption type, there has hitherto been wanting an adequate knowledge of the "relations existing between the percentage of ammonia in the solution, the temperature, and the pressure of the vapor. The only data available have been those obtained by Messrs. Perman and Sims, whose researches did not extend to pressures beyond 3 atmospheres and temperatures above 100 deg. C. In practice, pressures up to at least 8 atmospheres and temperatures around 220 deg. C. are met with. An extended series of experiments has recently been conducted by Herr Hilde Mollier, in a laboratory in Munich, from which the following formula (covering solutions containing from 10 per cent to 50 per cent of ammonia, pressures up to 10 atmospheres, and temperatures around 120 deg. C.) has been derived: $\text{Log } p = 5.106 - [1{,}220/T\ (0.00466\ x + 0.656)]$, where p = absolute pressure of the vapor in kilogrammes per square centimeter. T = absolute temperature in deg. C. x = percentage by weight of ammonia in the solution. If p = absolute pressure in pounds per square inch, and T = absolute temperature in deg. F., $\text{Log } p = 6.259 - [2{,}196/T\ (0.00466\ x + 0.656)]$.—Engineering Digest.

MAGNETIC SEPARATORS FOR VARIOUS USES.*

THEIR APPLICATION IN THE FOUNDRY AND MACHINE SHOP.

BY S. R. STONE.

Among the economies practiced in machine shops, foundries and metal-working establishments of various kinds, few are more suggestive than the use of magnetic separators, the principal applications of which, as thus far developed, will be found briefly outlined in the following article:

The halftone, Fig. 1, and the line cut, Fig. 2, show the type of machine now most commonly used in brass foundries and metal refineries for removing iron and

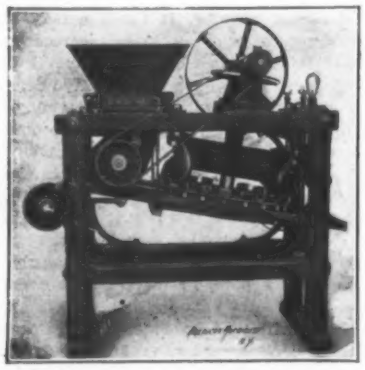


Fig. 1.—DISK PATTERN SEPARATOR.

steel from brass and copper turnings, borings, filings, punchings, fine scrap, washings, skimmings, etc., preparatory to remelting in the furnace or crucible. This is of the so-called "disk" pattern, and its operation is as follows:

The material to be treated is fed from the hopper *A* upon a vibrating conveyer *B*, over which it passes in a thin layer through the zone of operation covered by the rims of the wheels *C* carrying secondary magnets, *D D*, which attract the iron and steel, thereby separating it from the other metal, and discharge it over the sides of the conveyer into spouts.

The secondary magnets are saturated by the pole pieces *E E* of the primary magnets while over the conveyer, but are automatically demagnetized as they pass out of the magnetic circuit *F F* to the neutral position, where the rims of the wheels *C* overhang the conveyer. The non-magnetic material to be recovered passes off to final delivery at *G*, the lower end of the conveyer. At *H H* are located thumb screws for adjusting the inclination of the shaker *B*.

SEPARATOR FOR FOUNDRIES.

This type of separator is the one which has thus far been most widely installed, but there is every indication that in point of numbers used, as is already the case with respect to the tonnage of metal recovered, it will be far outstripped in the near future by the machines designed for foundries. Views of two of these are shown in Figs. 3 and 4.

Fig. 5 illustrates one of these separators with the side guards removed and the several parts indicated by lettering. In this *A* is the hopper, *B* the revolving screen, and *C* the magnet section. In operating it the sand comes out at *D*, the coke and slag at *E*, and the iron at *F*. The sand, coke, and iron can be collected in wheelbarrows placed under the separator, as shown in Fig. 4, or they can be dropped into bins and removed by a conveyer. It is used to recover iron from refuse, such as cinder-mill droppings, gangway scrapings, chipping-room dirt, etc., and has been built especially to suit the requirements of that particular class of service, being now one of the most important parts of the equipment.

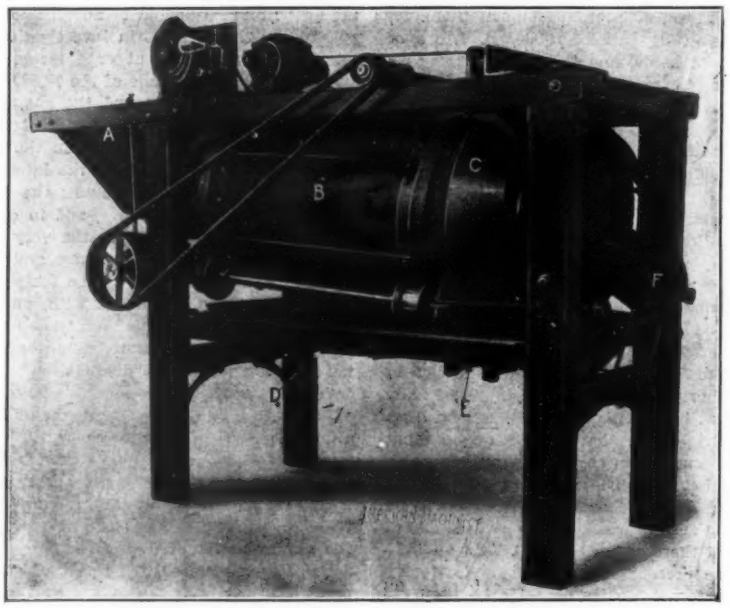
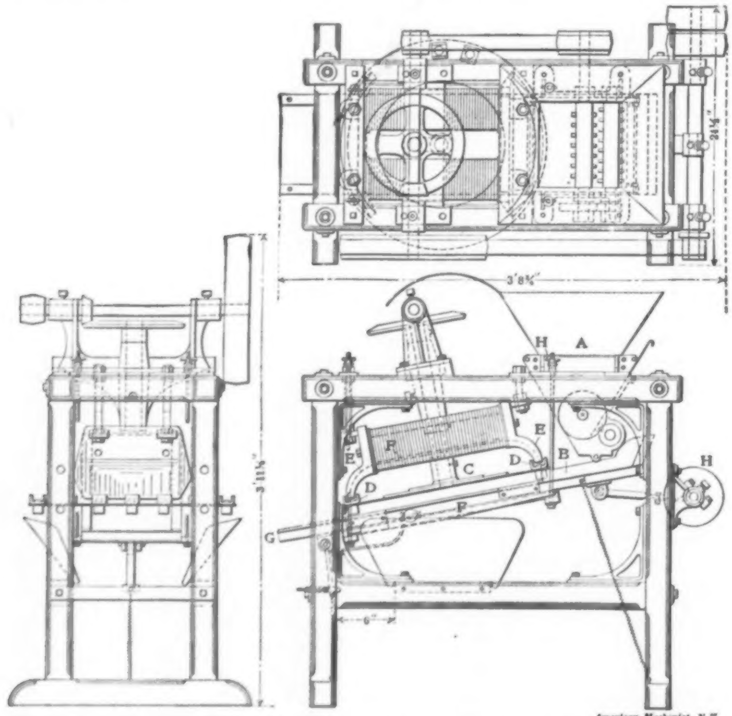


Fig. 5.—SIDE REMOVED FROM SEPARATOR TO SHOW ITS MECHANISM.



American Machinist, N.Y.

Fig. 2.—LINE CUT OF THE DISK SEPARATOR SHOWN IN Fig. 1.

SAVINGS EFFECTED BY SEPARATOR.

"Our old method," said an official of one of the large malleable iron and steel companies, whose experience is typical, "was riddling the sweepings from the foundry floor, and we estimate that we are now saving from one to one and a half tons of additional iron daily. We expect to do even better than this, as we are making the plant more complete by putting in a large rolling barrel to crush the cinder from our cupola and open-hearth furnaces." Others interviewed on the subject stated that they were recovering large quantities of iron which had heretofore been absolutely lost to them.

Where the refuse from the furnaces and molds, as well as the finer material mentioned above, is regularly put through this process, going back to the cupola to be melted over again with the pig iron and scrap, one foundry estimates that a saving of between twenty and thirty thousand dollars is effected in the course of a year, depending upon the tonnage of iron originally melted.

OPERATIONS OF SEPARATOR.

To illustrate the working of the system let us take cinder from a cupola, a very large percentage of the iron in which was formerly thrown away. This is first crushed in an ordinary cinder mill, and the iron left in the mill is ready for remelting. The screenings, however, contain by weight as much as 20 to 30 per cent of good iron, and these are next put through the separator.

The material first passes the screen section of the cylinder, which draws off the sand and dust. The

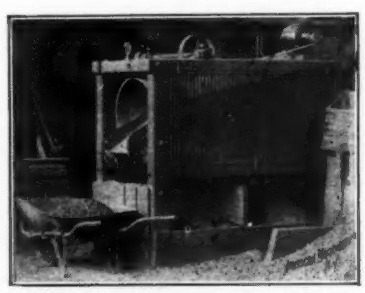


Fig. 3.—OUTLET END OF SEPARATOR FOR FOUNDRIES.

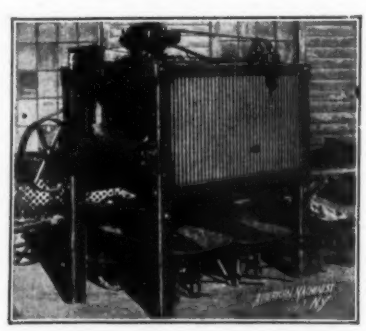


Fig. 4.—INTAKE END OF SEPARATOR FOR FOUNDRIES.

* American Machinist.

coarse part then moves into the magnet section, where the iron is caught by the magnets and carried to the high point of rotation, being discharged upon a perforated incline chute and thus to final delivery.

The coke, slag, and other non-magnetic materials pass out of the lower end of the cylinder and are delivered by a back-slanted chute into a wheelbarrow or conveyer.

Besides the actual recovery made of iron, this system effects a further economy, in that it saves at least 75 per cent in time, power, and wear and tear in the cinder mill, which does the work in about one-quarter of the time required, where riddling is afterward to be done. This is because the cinder mill may have larger openings between the staves. The fact that less labor is needed is also quite a consideration.

MATERIALS SEPARATED.

In handling the refuse from the molds, and the foundry and cleaning-room floor, three separations can be made, viz., sand, slag, and iron. The sand is delivered in a condition fit for various uses in the foundry, the coarse pieces of slag may be used for venting large cores, and the iron is ready for remelting, being sufficiently clean to require no further sifting.

In handling the floor scrapings, chipping-room dust, etc., the material does not, of course, need any crushing, but is simply shoveled into the separator without further preparation.

Another use to which magnetic separators have been put in the foundry, with considerable advantage, is in connection with continuous molding systems where slop, etc., in the form of fine shot is separated from the sand when it leaves the conveyer on its return journey to the bins, thereby enabling it to be used over and over without any further treatment than the addition of the fresh sand needed. From the fact that the process of separation occurs at a stage when the sand is still soft, the particles are broken up and prevented from caking. A feature of the best type of foundry separator is that it cannot be overloaded so as to lose iron.

CONTINUOUS DISCHARGE.

The delivery of the material is continuous, and the magnets successively discharge the recovered iron at the proper point in rotation without breaking the circuit.

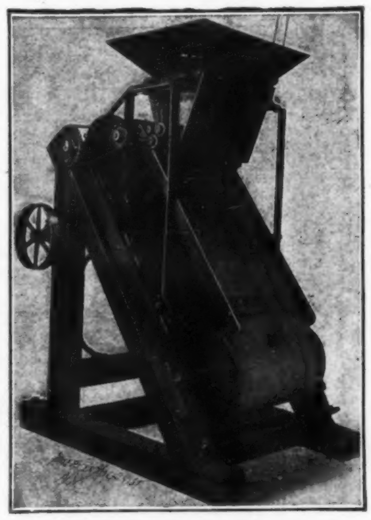


Fig. 10.—SEPARATOR WITH MAGNETS UNDER BELT.

If built with a large screening surface and constantly discharging magnets, the separator will handle damp material, such as crushed cinder that has been wet to prevent dust in milling, and it takes care of anything that can be handled with a shovel. Stray bricks, gaggers, and large pieces of refuse liable to be found on the floor of a foundry readily pass through the machine.

For its operation only common labor of the most ordinary intelligence is necessary, as there is practically nothing to get out of order. There is no need of having switches, contacts, nor brushes to wear out, spark, or burn off, except in connection with a motor used to drive it. This the laborer is not supposed to handle to any greater extent than throwing a small switch.

ELECTRICAL OPERATION.

The separator takes up but little space, say 3½ by 7 feet for foundry capacity up to a melt of 50 tons daily, and it can be readily moved from one location to another, particularly if motor-driven. Electrically operated machines are usually preferred, as one can be set up in any place merely by having a wire run to it, regardless of line shaft, pulley, and belting, and is ready for work as soon as connected to the service circuit. Each separator thus equipped should be provided with a motor on a sliding base, for tightening the belt between the motor and arbor, also a starting box, switch panel, and dust cover, or screened ends, for the motor.

The power required for machines of the ordinary sizes ranges from ½ to ¾ horse-power for the mechani-

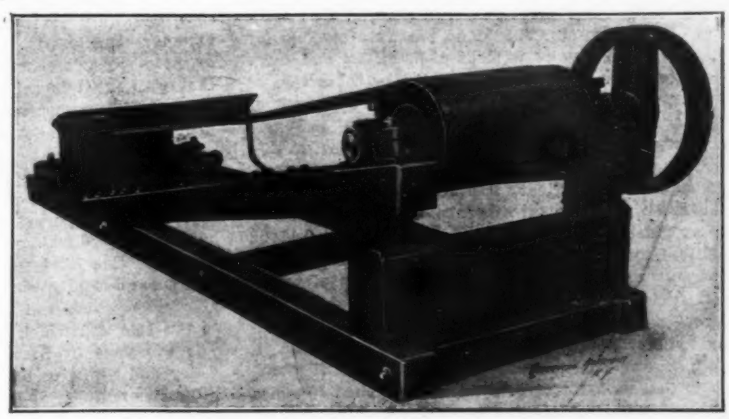


Fig. 8.—SEPARATOR FOR REMOVING IRON PRODUCTS FROM COAL.

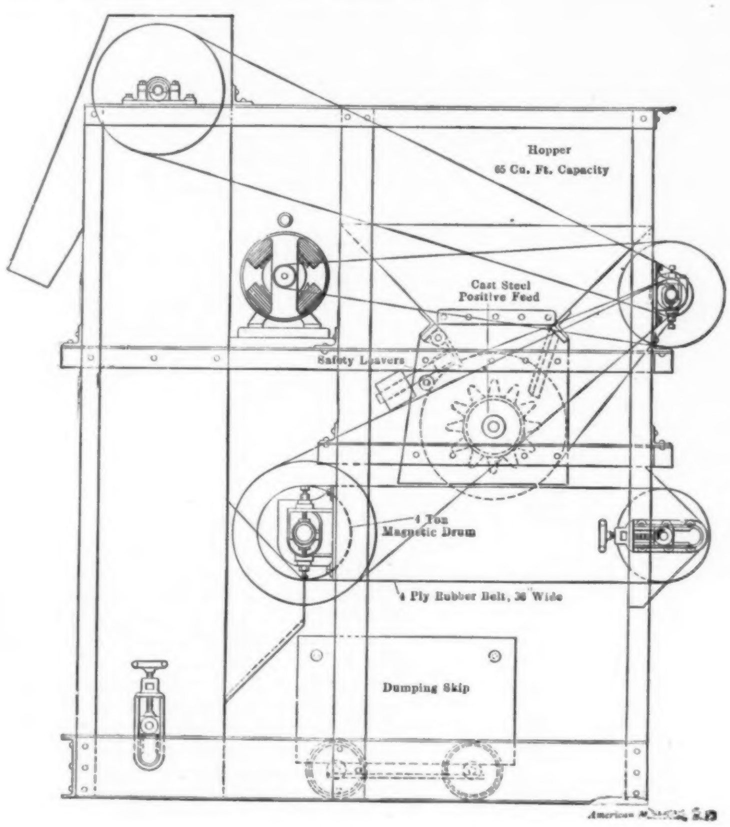


Fig. 6.—AUTOMATIC MAGNETIC SEPARATOR FOR FOUNDRY USE.

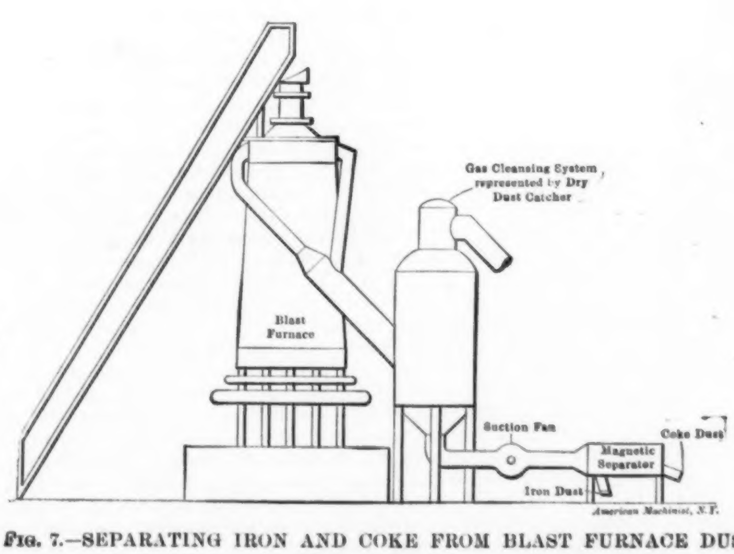


Fig. 7.—SEPARATING IRON AND COKE FROM BLAST FURNACE DUST.

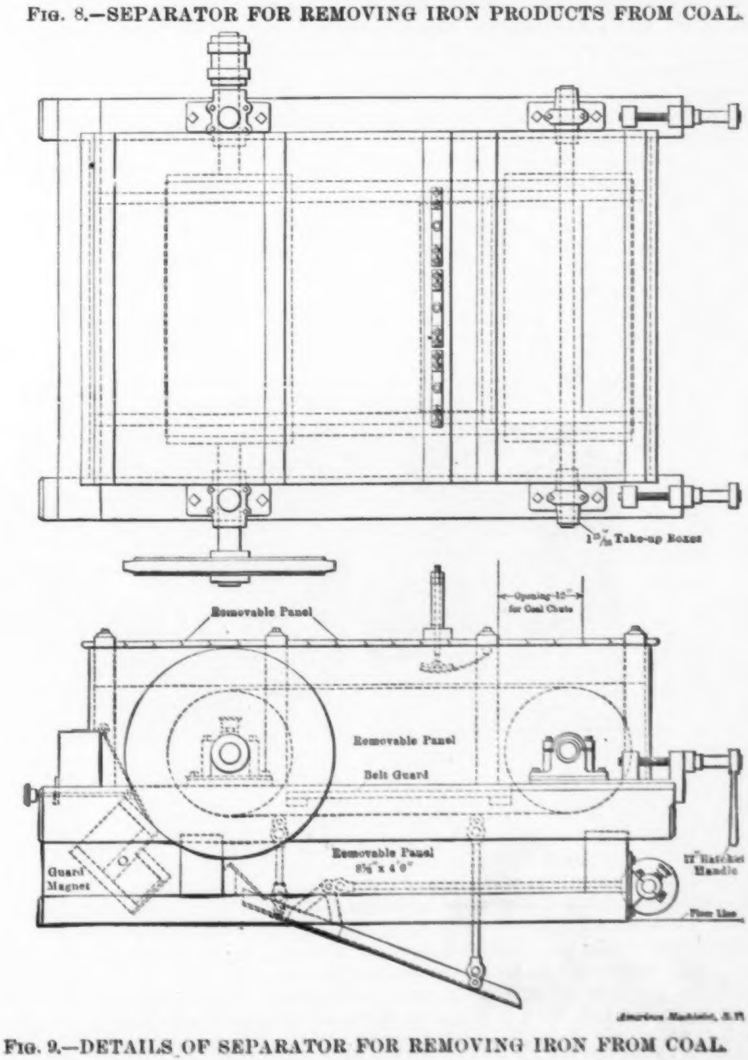


Fig. 9.—DETAILS OF SEPARATOR FOR REMOVING IRON FROM COAL.

cal operation and not to exceed ¼ horse-power for the magnet; so that a 1-horse-power motor is ordinarily sufficient. Direct current is, of course, needed, as alternating current cannot profitably be utilized to excite the fields of a magnet; but, where the latter is used exclusively, a small direct-current generator can be installed at little cost.

CONVEYER SYSTEMS.

If the quantity of material handled daily is sufficient to warrant it, considerable saving of operation can be effected, and the net economy thereby increased, by putting in a conveyer system which will deliver the discharge from the cinder mill, or the refuse shoveled up from the floor, directly into the mouth of the separator and then carry the separations to their various destinations.

In Fig. 6 may be seen the side elevation of a machine especially fitted with attachments for use in connection with the conveying or crane system of a steel foundry. By means of this the refuse collected in large boxes at night and brought to a large receiving hopper is carried away on a belt, automatically fed into the separator at a specified rate, and the useless part of the separation elevated to a discharge into cars outside the building.

There is no end to the variety of systems of this kind which can be worked out, at relatively small expense, to suit local conditions.

In planning them, however, provision should be made for ordinary barrow and shovel operation whenever such may be desirable or necessary. For example, the separator must stand high enough above the floor to permit of receiving the different separations in wheelbarrows, if required, and at the same time low enough in the frame to allow for easy shoveling from the floor into the mouth of the cylinder.

It may also be observed here, in general, that every part of the separator should be readily accessible for inspection and repairs without dismantling, and there ought to be no parts unduly affected by the action of rust or frost. The frame must, of course, be built of non-magnetic material, preferably heavy, seasoned, non-warping wood strongly braced and bolted.

SAVINGS VERSUS COST OF INSTALLATION.

A separator in ordinary intermittent operation ought to pay for itself in three months or less. If working on an old dump continuously, thirty days should be sufficient to cover the initial cost, as was the case recently at an iron foundry within two miles of where this article was written. The first machine of the type shown in Figs. 4 and 5 was installed in a 50-ton-per-day foundry about eight years ago, and has been in continuous operation ever since, having effected a saving in that period equivalent to not less than 40 times its cost, including labor.

A couple of old foundrymen who rigged up a portable outfit, with a small gasoline engine as the motive power, and made contracts to clean up dump heaps in the neighborhood of some large iron-working plants, were, at last accounts, clearing an average of fifty dollars per day over their expenses, and they hired laborers to do the actual work.

DUST FROM BLAST FURNACES.

One of the most enterprising of the iron-producing companies of the country is now considering the installation of magnetic separators with which to recover both iron and coke from the dust blown out at the tops of the blast furnaces. The construction of this is shown in the line cut, Fig. 7.

The scheme is to have this dust pass from the hood of the furnace into a large pipe known as a downcomer, and then into a settling tank, from the bottom of which it will be drawn off by a vacuum suction system into a magnetic separator, where the two principal materials will be sent down different chutes into larries and taken thence to be nodulized for reuse in the furnace.

The details of the plan have not yet been worked out to the satisfaction of those who are responsible for it, but there can be little doubt that it will eventually mean one step more in the great movement of the iron and steel world for eliminating waste.

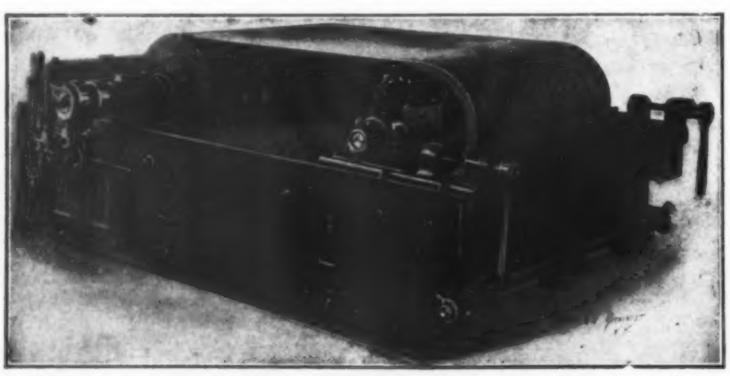


FIG. 11.—SEPARATOR WITH MAGNETIZED PULLEY.

SEPARATING COKE, EMERY, CARBORUNDUM, ETC.

In Fig. 8 is reproduced a photograph of the principal parts of a type of separator installed in one of the largest by-product coke plants of the country, and Fig. 9 is a line cut showing it more in detail. The object of this separator is to remove, from the coal, material such as old railroad iron, pick heads, shovels, etc., which would damage the crushing rolls; and, incredible as it may seem, one coke plant well known to the writer shows an average of about one ton of metal diverted each week from the crushers. To insure that none of it gets past the separator, an independent guard magnet is constructed at the discharge end of the belt, but this seldom comes into action, as the lines of force concentrated in the regular zone of separation are sufficiently powerful for all ordinary purposes.

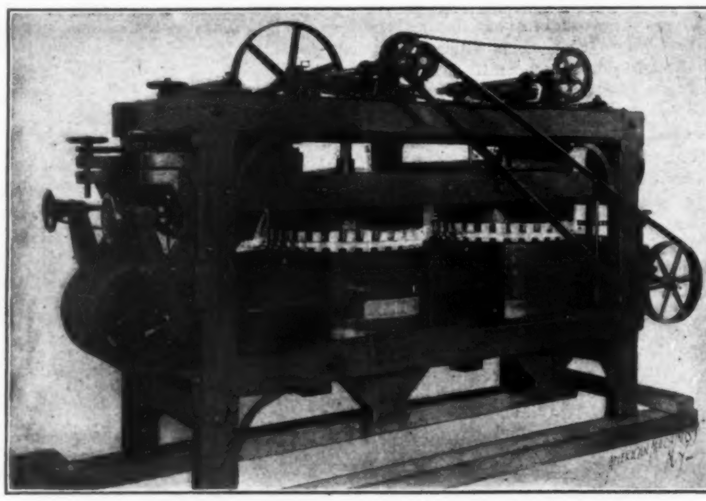


FIG. 12.—TYPE OF SEPARATOR USED IN ORE REDUCTION.

Not less interesting than anything contained in the foregoing is the use of separators for recovering emery, corundum, garnet dust, and other abrasives used on belts for polishing heavy blades. The first application of this kind was made in a plow works. At first some difficulty was experienced on account of the glue with which the abrasive material was secured to the belt and which was worn off with it, but this was overcome by first soaking the material in soda water and draining off the solution. With the separator about fifteen dollars' worth of abrasive is recovered in one plant each day, and it is very nearly as good as when first used.

BELT SEPARATORS.

Two types of separators, one of which shows magnets underlying a belt and the other merely a magnetized pulley, are illustrated in Figs. 10 and 11.

Another field of usefulness for magnetic separators which, while not of direct interest to machinists and founders, has considerable suggestive value, is the elimination of bits of metal such as buckles, nails, pins, hooks and eyes, etc., from textiles, leather or rubber scrap, paper waste, etc. These are usually ground up for retreatment in the mills or factories using such material. Other uses similar to that described for coke plants, where pieces of iron or steel that would be injurious to the machinery are removed at some stage of the process, include the treatment of bones, hoofs, etc., in glue factories; tobacco stems in snuff works; grains in malt houses and distilleries; herbs and minerals in drug mills; and ground meal in flour mills.

Still another use for magnetic separators is in preventing damage to the grates of furnaces in power plants by having pieces of iron or steel pass in with the coal. A very simple guard consists of a magnetized grizzly placed in the delivery chute, but it is sometimes inconvenient to get at such a contrivance to remove the iron that adheres to it, and a better arrangement could probably be made in most cases, depending upon the particular conditions encountered.

USE IN ORE REDUCTION.

In the field of ore reduction magnetic separation has, for some years, been extensively used, either on materials naturally magnetic or that have been rendered so by being converted into oxides through roasting. The separations tried have thus far included treating magnetite iron ore, eliminating iron pyrites from zinc blende, recovering the copper values from chalcopyrite ore, concentrating tungsten, garnets, monozite, and other rare minerals, separating wolfram from tin ore, apatite from hornblende, and cobalt, nickel, etc., from their worthless gangue.

In Fig. 12 is shown one of the standard separators used for this work, which is similar to that illustrated by Fig. 1, except that it has a double magnet, each part of which is much more powerful than any used for other styles of separators and is capable of making five separations, consisting of the non-magnetic material and four grades of magnetite of various degrees of attractibility.

This subject is such a large one that to treat in more detail the various phases of it mentioned in the foregoing would require an extensive series of articles, but enough has doubtless been said to indicate the profit of considering it with relation to the requirements of any individual foundry, shop, or specific industry. For the illustrations the writer acknowledges indebtedness to the Dings Electro-Magnetic Separator Company, of Milwaukee.

THE ETHER OF SPACE.

By CHARLES W. RAFFETY.

AS ONE who has read with the greatest appreciation the work recently written by Sir Oliver Lodge on this subject, I take it that the following statements represent fairly well the condition of scientific opinion at the present time:

1. The fundamental units of which matter is composed are probably individualized regions of the universal ether, neither condensations nor rarefactions, but distinguished by some kinetic structure from the unmodified ether surrounding them.

2. The ether, as a whole, is stationary, there being nothing of the nature of ether currents, but it possesses an exceedingly fine-grained circulation in closed curves, its elasticity being of kinetic origin.

3. So far as the motion of a mass of matter is concerned, there is no ethereal viscosity, and, consequently, the earth carries no ether with it in its motion. We therefore live in an ether stream due solely to the earth's motion in space, and having the full value due to its velocity, the failure of Prof. Michelson's delicate experiment being due to a lessened cohesion (of electromagnetic origin) in any length of matter carried at right angles to the ether stream.

The question arises as to whether the ether which forms any mass of moving matter remains the same. Assuming the above statements, there appear to be two alternatives. Either the ether, distinguished by special structure, which composes the ultimate units of which matter is built up, has a bodily transfer through space, or the ether in the line of approach must be rapidly caught up in the advancing vortices (or whatever the structure may be), fused into their being, and as rapidly liberated along the line of recession.

If the former supposition be correct, there must be a region of slip in the ether surrounding the ultimate units (electrons); if the latter, we have the very interesting conception of matter being incessantly made and unmade as regards its fundamental units with a speed proportional to the velocity of motion. All the physical properties of a given mass of matter would remain constant, while the ether, the substratum of its existence, was changing.

RECENT ELECTRICAL PROGRESS.*

THE ARTIFICIAL LIGHTING FIELD.

BY ALBERT F. GANZ, M.E., PROFESSOR OF ELECTRICAL ENGINEERING, STEVENS INSTITUTE OF TECHNOLOGY.

Continued from Supplement No. 1759, page 188.

SINCE the beginning of this century incandescent lamps containing filaments of metals and giving efficiencies much higher than could be obtained with carbon have been introduced. Osmium was the first metal tried, and a fairly satisfactory lamp, having a specific power consumption of 1.5 watt per candle, was obtained. A number of osmium lamps have, in fact, been used commercially in Germany. However, the very limited available supply of osmium has prevented the commercial introduction of the osmium lamp.

About the year 1904 lamps employing tantalum filaments were placed on the market, having an efficiency of about 2 watts per candle, with a useful life greater than that of the carbon filament lamp on direct-current circuits. Processes were developed for producing pure, ductile tantalum which was then drawn into fine wires for use in the lamps, and these tantalum lamps have come into considerable commercial use. A peculiarity of the tantalum lamp is that it has a short life when used on alternating current. The lamp is therefore inherently a direct-current lamp.

About the year 1905 incandescent lamps, having filaments of tungsten, were brought out in Germany, having an efficiency of about 1.25 watt per candle with a useful life claimed to be greater than that of the carbon filament lamp and equally good on alternating and direct current. These were quickly introduced on a large scale. The manufacture of tungsten lamps was also started in America about 1907, and these lamps are now rapidly coming into use. The present very high cost of these lamps is, however, a serious obstacle to their general introduction. Since tungsten is not ductile, the tungsten filaments cannot be drawn into fine wires as in the case of tantalum. The production of a filament of tungsten, therefore, presents many difficulties, with the result that a number of different processes for producing these filaments have been developed. Since the specific resistance of tungsten is very much less than that of carbon, a filament of tungsten for a lamp to be operated at a given voltage must be very much thinner and longer than a carbon filament for the same voltage. For this reason tungsten filaments are admirably suited for heavy current, low-voltage series lamps for use on constant current circuits for street lighting. Multiple lamps for 110-volt, constant potential circuits are now also manufactured in sizes down to 20-candle-power, but the filaments in these lamps are extremely small in diameter. When the tungsten filament is incandescent it is extremely soft, and the loops, especially those for high-voltage lamps, require supports to keep them in position. The first tungsten lamps were for this reason capable of operating only in a vertical downward position. The lamps have been so improved that they can now operate in any position. The tungsten filament is, however, extremely fragile, making it liable to become broken when subjected to vibration, so that these lamps are not suitable where subjected to vibration, as, for instance, on trains or boats. In these latter places the tantalum lamp is frequently used.

Both the tantalum and tungsten filaments have a positive temperature coefficient, and for this reason are less affected by fluctuations in line voltage than ordinary carbon filaments. The light given by tantalum and tungsten lamps is also much whiter than that given by carbon filament lamps owing to the higher temperature at which these filaments are operated. Another peculiarity of these metal filament lamps is that they do not depreciate from their initial candle-power until the filament finally breaks. It is at times even possible to repair a ruptured tantalum or tungsten lamp filament by judiciously shaking the lamp with the voltage on, until the broken ends of the filament come in contact and are welded together by the intense local heat at the point of contact. Such a weld is frequently quite strong, enabling the lamp to continue in service for a considerable time.

A prominent example of an installation of tungsten lamps for street and park lighting is found in Riverside Park and Riverside Drive, High Bridge Park, and St. Nicholas Park, New York city, where the New York Edison Company has recently installed about 300 75-watt, 60-candle-power tungsten lamps, mounted on lanterns of special design and carried by ordinary posts about 10 feet high from the surface of the ground. These lamps are supplied in multiple from the ordinary Edison three-wire system by means of buried cables, making it an unusually attractive lighting installation. This installation is described in a paper by Mr. S. G. Rhodes, in the February, 1909, issue of the "Transactions of the Illuminating Engineering Society."

* Reprinted from the American Gas Light Journal.

Another form of incandescent lamp which has been proposed, but which has not been introduced commercially, is the Helion lamp invented by Messrs. Parker and Clark, of New York city. The filament for this Helion lamp is made from a carbon filament by subjecting it to heat treatment in a gaseous compound containing silicon. It is stated that the filaments take on a surface deposit of silicon, and, with this surface deposit, a greatly increased efficiency and a much greater whiteness of light are obtained. A desirable quality of the Helion filament is its very high specific resistance, giving a comparatively short and thick filament for 110 volts and making the lamp suitable for higher voltages. A peculiarity of the Helion lamp is that it does not require a vacuum for its operation, but can be used in the open air.

The advances made in the construction of incandescent electric lamps are well shown by the following table, giving the approximate dates when each lamp was introduced in America, and the specific power consumption expressed in watts per mean horizontal candle and in watts per mean spherical candle. The latter figures are obtained from the former on the assumption of a spherical reduction factor of 0.8:

Type of Lamp.	Approximate Date of Introduction.	Watts per Mean Horizontal Candle.	Watts per Mean Spherical Candle.
Early carbon filament	1880	4 to 6	5.0 to 7.5
Improved carbon filament	1888	3.5 to 3.1	4.4 to 3.9
Metalized or graphitized filament	1905	2.5	3.1
Tantalum	1904	2.0	2.5
Tungsten	1906	1.25	1.56

An interesting departure in the construction of an electric lamp of the incandescent type is the Nernst lamp, which was first brought out by Dr. Nernst, in Germany, about the year 1898. The Nernst lamp has been commercially developed in America by the Nernst Lamp Company, one of the Westinghouse interests. The light-giving conductor, or glower, as it is called, consists of a cylindrical piece of porcelain-like material, from one-half to about one inch in length, for circuits of from 100 to 250 volts. This glower is made from a suitable mixture containing the oxides of rare metals, similar to that used in making Welsbach mantles. The peculiar characteristic of this glower is that it is an insulator when cold, but becomes a good conductor and an excellent and efficient illuminant when heated to a high temperature. It is therefore necessary to employ a device which will heat the glower on starting to a temperature at which it will conduct electricity, after which the current will maintain the glower heated and conducting. It is also necessary to provide an automatic cut-out for cutting the heater out of circuit after the glower has been made conducting. This heater consists in practice of a very fine platinum wire wound upon a small tube or thread of clay and placed close to the glower. The glower is not inclosed in a vacuum, but is surrounded by a glass globe to prevent too rapid dissipation of the heat of the glower. Another characteristic of this glower is that it has a negative temperature coefficient, so that if it were connected to constant potential mains it would burn itself out after it has been heated and rendered conducting. In this respect it resembles an electric arc. For this reason a steadying resistance, called a ballast, must be added in series with the glower. In the Nernst lamp, the glowers take from 60 to about 120 watts, and, as made in America, from one to four glowers are employed in one lamp, giving from 50 to about 500 mean lower hemispherical candles. The heaters are placed horizontally above the glowers. Owing to the high temperature at which the glowers operate, a brilliant white light is obtained, which makes the light very desirable where colors should appear as nearly as possible the same as in daylight. The glowers and heaters have a life of 500 to 800 hours, and these are mounted together and are so arranged that they can be easily replaced. The ballast resistances have a life of several thousand hours, and can also be readily replaced. The first Nernst lamps manufactured in America were designed to operate on alternating current, and these gave only a short life on direct current. Later, Nernst lamps, giving a long life on direct current, were also introduced. Practically all of the light from a Nernst lamp is projected downward in the lower hemisphere, and hence no reflector is ordinarily required. The lamp is peculiarly well adapted for illuminating large interiors, such as stores, etc. These lamps have recently been greatly improved in efficiency, and the makers now claim a specific power consumption of about 1.2 watt per mean lower hemispherical candle. These Nernst lamps start in 20 to 30 seconds. A special Nernst fixture has also been placed on the market during the past year, in which the automatic cut-outs and ballast resistances are attached to the fixture; the glowers and heaters are secured to a porcelain base and surrounded by a glass globe, the base having a screw contact attachment so as to permit of being replaced by unscrewing exactly like an ordinary incandescent lamp. Recently a luminous type of heater has also been developed which gives some light instantly, thereby producing a partial illumination before the glower has become active. It is claimed that with this new heater the glowers will start in 10 to 15 seconds.

Nernst lamps are generally used in multiple, on constant potential circuits, for indoor lighting. The largest single installation of Nernst lamps in America is in the Marshall Field & Co.'s stores, Chicago, where about 14,000 glowers are connected on direct-current circuits, taking the place of about 57,000 16-candle-power incandescent lamps. Nernst lamps can also be used on constant current alternating current circuits for street lighting by using a special form of series transformer for each lamp.

Development of Vapor Lamps.—Luminous effects produced by means of electric discharges through gases or vapors inclosed in glass tubes, exhausted to a partial vacuum, date back to the famous Geissler tubes, which were developed about the middle of the last century. These were, however, used only for lecture room experiments illustrating electric discharges, and no attempt was made to use them as sources of light. Electric lamps in which gases or vapors are raised to incandescence by an electric current have, however, been developed commercially during the past twenty years. The two leading types of vapor lamps developed in America are the Moore vapor lamp, or Moore tube, and the mercury vapor lamp.

The Moore tube was first described before the American Institute of Electrical Engineers, in 1896, by the inventor, Mr. D. McFarland Moore, and aroused considerable interest owing to its being totally different from other illuminants and embodying a number of remarkable properties. In its original form this lamp consisted of a glass tube containing highly rarefied air or other gases, and heated to incandescence by high potential electric discharges. The energy for exciting these tubes was derived from the inductive kick of a coil, whose circuit was rapidly interrupted by a mechanical break in a high vacuum. The chief difficulty found with these tubes was that the vacuum increased as the tubes were used until the electric discharges could not be forced through them, thus giving the tubes a comparatively short life. After about ten years of study and experiment, Mr. Moore finally overcame this difficulty by providing a most ingenious automatic feeder valve, called a vacuum regulator, which admits to the tube at suitable intervals a minute quantity of gas to supply the losses which occur during action. The color of the light in this lamp depends upon the gas within the tube, and for obtaining light of different colors tubes containing various gases have been made. For instance, ordinary air gives a light of a distinctly pink color; nitrogen, which can be obtained by drawing air over phosphorous to remove the oxygen, gives a golden yellow light, while carbon dioxide gives a white light. The Moore vapor lamp, as placed upon the market during the last few years by the Moore Electrical Company, of Newark, N. J., consists of a glass tube about 1.75 inches in diameter, and of a length varying from 25 to 200 feet. The ends of this tube terminate in a metal box, which contains all the auxiliary apparatus, and from which the tube proceeds over any desired path throughout the area to be illuminated and without any wires. The tube is excited from the secondary of a high-potential transformer, whose primary is connected to the regular alternating current lighting circuit, the current being introduced through platinum wires sealed into the glass tube at each end and connected to carbon electrodes in the interior of the tube. The Moore lamp is therefore essentially an alternating-current lamp, and requires a frequency of at least 60 cycles

per second for satisfactory operation. The light from the Moore tube is of low intrinsic value, running in practice in the neighborhood of 10 candles per foot of tube, this giving an ideal diffusion of light. As there is nothing which deteriorates in the operation of a Moore tube, its life is very long. An interesting and unique example of Moore tube lighting is to be found in the New York Post Office, where the mezzanine floor is entirely lighted by Moore tubes arranged in 35 parallel rows, each 114 feet long, placed directly under the ceiling.

(To be continued.)

THE MAKING OF A NEW AMERICAN COTTON.

INTRODUCING THE EGYPTIAN COTTON INTO AMERICA.

BY CHARLES RICHARDS DODGE.

The highest-priced cotton in the world is produced in Egypt, selling for nearly twice as much per pound as the American Upland varieties. Notwithstanding that the United States produces considerably more than half of the world's supply of cotton—amounting to a value of over six hundred and forty millions of dollars in a single year—we import Egyptian cotton direct to the value of eleven and a half millions of dollars annually, and indirectly a million more through Great Britain.

The large demand by American manufacturers for this high-priced cotton is due to its superior quality, and because it is peculiarly adapted to mercerizing and other processes that give a high finish to the manufactured cloth and cause it to resemble silk. Other special advantages of these cottons is their clearness and luster, as well as capacity for taking dyes, which fits them for mixing with silk and for filling sateen, India linens, and other goods which show a brilliant surface; the darker, brownish color of some varieties admits of their use in Balbriggan underwear, and in "ecru" lace curtains, without dyeing either fiber or fabric, and they are also particularly adapted to the manufacture of sewing thread where strength is desired.

Efforts have been made from time to time, in the past, to produce the Egyptian types of cotton in this country, and about twelve years ago Mr. W. H. Wentworth, a Texas cotton planter, conducted some experiments which were promising, but which in the end failed to show practical results. Within a few years the United States government, through the Department of Agriculture, has begun active experimentation in the culture, and singularly, these experiments are not being conducted in the cotton region, so called, but in arid Arizona, where irrigation must be depended upon by the farmers to secure any crop. This most important investigation is one of the drops in the bucket in connection with the work of the Western Agricultural Extension, or Reclamation Service, a feature of the work of which is to find new, paying crops for the people living in hot, rainless regions such as Arizona and the Southwest. The experiments are being conducted by Mr. T. H. Kearney, in charge of Alkali and Drought Resistant Plant-breeding Investigations of the Bureau of Plant Industry, and by Mr. William A. Peterson, the farm superintendent of the Western Extension Investigations.

The investigators recognized at the outset of the work the desirability of securing a type of cotton for culture in this region which would be distinctive of the region in comparison with other cotton-growing sections, necessitating intelligent selection of varieties and acclimation. The principal Egyptian varieties of cotton are known by such names as Mit Afifi, Jannovitch, Abbasi, Ashmuni, Nubai, etc. All of these were tried, though the first and second named were found to give the best results in acclimation, and the others were discarded. The Abbasi variety produces a superior white fiber, the first picking of which sometimes sells at a higher price than any other Egyptian cotton. But as it too nearly resembles American Sea Island cotton, it was considered inadvisable to cultivate it.

FIG. 1.—EXPERIMENTAL COTTON FIELD AT YUMA, ARIZONA.

THE MAKING OF A NEW AMERICAN COTTON.

These experiments, which were begun in 1902 at San Antonio and Barstow, Texas; at Carlsbad, New Mexico; at Yuma, Arizona, and at Calexico, California, are now conducted chiefly in the valleys of the Gila, Salt, and Colorado rivers in Arizona, the largest plantation being located on the Pima Indian reservation at Sacaton, while another smaller tract is located at Yuma. The remaining areas are under the control of individual farmers near Phœnix, who are working in co-operation with the government specialists in charge of the investigation. During the first three years of the work the results were far from encouraging. It is a simple matter to plant seed brought several thousand miles from the environment of the parents and make it grow, but it is quite a different matter to overcome adverse conditions which may modify or completely change plants and fruitage, and make it not only grow but yield a product like that of the parent plant. In the earlier Arizona experiments the plants derived from the newly-imported seed grew rankly, and were relatively sterile; the bolls or capsules opened very late and imperfectly and the cotton was short and coarse. It was Egyptian cotton in name, but not much better than the common Upland of the country. Then began the real work of selection and acclimation, and for six years it has been prosecuted patiently, intelligently, and unremittingly, with results at the close of last season that are more than encouraging, and which give the promise of full success.

FIG. 2.—EGYPTIAN COTTON PLANT, CROP OF 1903, SHOWING RANK GROWTH, YUMA, ARIZONA.

As far as the Mit Afifi variety is concerned, the improvement since the first experiment in culture was attempted has been very marked. This variety, planted at Yuma, yielded in 1907 at the rate of 990 pounds of fiber to the acre, or nearly two bales of commercial cotton. The lint averaged nearly 1½ inches long, and preserved the delicate brownish color so desirable in this type of cotton. The cost of picking was only one and one-half times as much as for the large-bolled Upland varieties, while the value of the fiber per pound was almost double. Samples of the Yuma crops of 1907, submitted to twenty-two buyers or users of Egyptian cotton in this country, were classed as equal to the best grades of the imported product, and worth 23 to 25 cents per pound. The average price of all grades of imported Egyptian cotton at Boston in 1907 was 21.9 cents per pound. At that time American Middling Upland was worth 12 to 12½ cents. Low-grade imported Egyptian was quoted at 12 to 15½; current, 14 to 18; good, 16½ to 19; and high-grade, 17½ to 21. The Arizona Egyptian was classed with the high-grade imported, and the opinion was unanimous that the Arizona-grown Egyptian could be substituted for the best grades of the imported product.

It will be seen, then, how great are the possibilities of this culture, although at present the department is urging farmers living in the region to begin in a small way, that they may not only learn how to produce and market the crop, but also how to keep up the standard and prevent the plants from deteriorating. This is essential to success, as without constant vigilance and careful selection of seed from year to year the cotton will revert to the earlier types, losing in quality, weight of fiber, and even in length of staple. In other words, after producing by careful experimentation through a series of years a type of plant that will yield a high-grade fiber, in order to keep this high-grade product up to standard it will be absolutely necessary to practice continuous selection of seed. Such a system of intensive breeding by careful selection of the very best individual plants will need to be carried on, therefore, by governmental institutions, or through the efforts of a few of the best farmers of a locality, who may make a specialty of producing superior seed. Such selection is accomplished by going over the field before the first picking and marking with a bit of cloth, or in some other way, the plants which show greatest productiveness, with finest quality of fiber. The yield from these marked plants is picked and ginned separately, the seed being kept apart from that produced over the general area, and put aside for the next year's planting.

But there are other considerations. Irrigation methods must be more fully studied, as it has already been shown that the plants are extremely sensitive to differences in soil moisture, and that both yield and quality of fiber depend largely upon the manner in which the water is applied. Further, the very form of the plants from the first period of development through the subsequent stages of growth depends upon their receiving not only the right degree of moisture, but at the proper time—too much or too little water, or at too long or too short intervals between irrigations, proving disastrous. Irrigation is as apt to be overdone in Egypt as in other countries where the cloud supply of water is insufficient; and it is an interesting fact, in connection with the above, that about ten years ago, when the river Nile was exceedingly low and the water supply limited, the fiber produced in many localities was longer and finer than that produced the previous year, when there was an abundant water supply. There is a point, however, in the matter of withholding moisture from the soil that the grower cannot go beyond without suffering loss; the result will be abnormally small plants which can only give low yields and short, inferior fiber.

Altogether, ten irrigations are commonly given between the date of planting and the first picking, care being taken that the last watering will be so timed that the soil will have become very dry before picking begins.

Another important consideration—and this is one of the most serious problems developed by the investigation—is the elimination of hybrid plants. Where common Upland cotton is grown in the vicinity of the Egyptian cotton fields, the cotton flowers are visited

by bees and other insects in large numbers, which carry the pollen from plant to plant, resulting in the contamination of the acclimated Egyptian stock. While numerous hybrids appeared last season, fortunately the best selections seem to have escaped, and these will be relied upon for the basis of pure strains. Otherwise, it will be necessary to import a stock of fresh seed and again go through with the work of acclimation. Such contamination results in changing the

FIG. 3.—TYPICAL MIT AFIFI COTTON PLANT, CROP OF 1907, SHOWING EFFECTS OF SELECTION AND ACCLIMATION AT YUMA, ARIZONA.

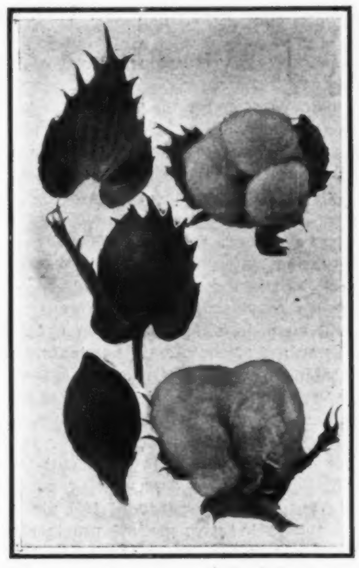


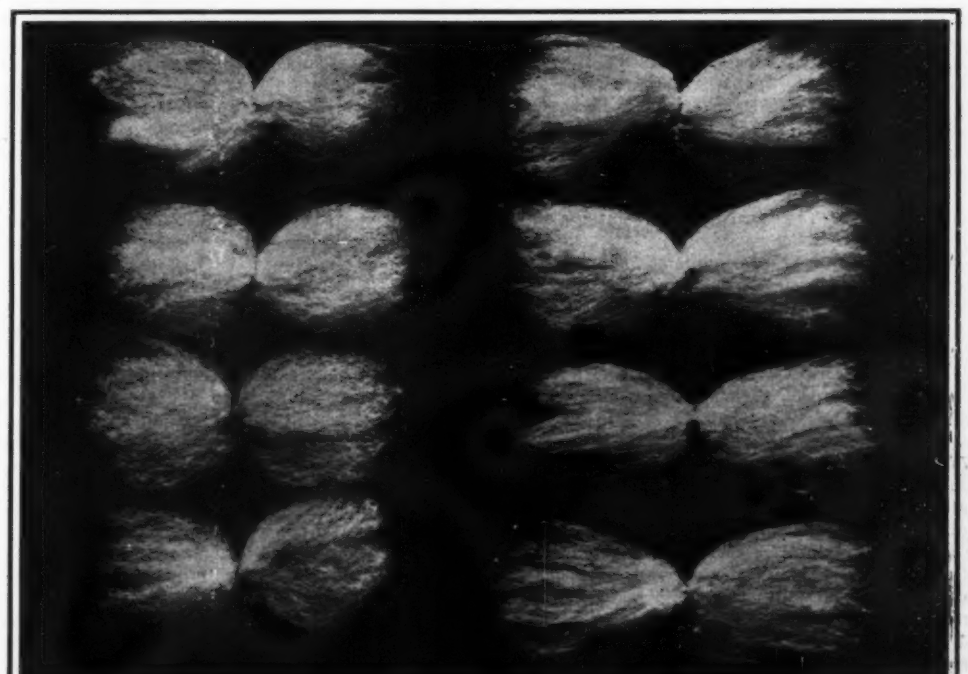
FIG. 4.—OPENED AND UNOPENED BOLLS OF MIT AFIFI COTTON, YUMA, ARIZONA, 1907.

length, color, and texture of the Egyptian cotton, which when mixed with the general crop lowers the quality of the entire product. The commercial value of Egyptian cotton largely depends upon its uniformity, which is one reason why it is so highly prized by spinners, and why it brings such high prices.

In classifying the 1908 product six grades were recognized by Mr. John A. Walker, a Boston expert in this type of cotton, and now connected with the government work. Nearly 60 per cent of the Yuma product came into the third grade, and 15 per cent into the fourth grade, stapling 1⅜ inches and 1¼ to 1⅜ inches respectively. Sacaton cotton graded 36 per cent third and 60 per cent fourth. While a length of 1⅜ inches in the imported Mit Afifi is regarded as satisfactory to the trade, it is believed to be desirable to produce a longer staple in the Southwest.

It should be noted that the old-fashioned saw gin, which is used throughout the southern cotton States for separating the seed from the fiber, cannot be used in cleaning long-staple cottons, and another type of machine, known as the roller gin, is employed. A machine of this type—an English make almost universally operated in Egypt—has been installed for these experiments under the auspices of the Indian Office and the Department of Agriculture, and this was used to gin the last season's crop.

With the growth of this new "American" cotton fairly established, millions of dollars will be annually saved to our country, and to that extent the farmers of the Southwest will be directly benefited. Mr. Kearney states that the climatic conditions of the Colorado River region in southern Arizona and southeastern California are unrivaled from the standpoint of cotton growing. At least 600,000 acres of excellent land are, or soon will be, under ditch in the principal river valleys. One-fifth of this acreage could produce the average amount of Egyptian cotton annually imported into this country. The soils are for the most part very fertile, and an abundant and permanent supply of water for irrigation is at hand. It has already been demonstrated that a yield of two bales per acre is possible in this region, when the long but almost rainless summers, deep alluvial soils, and irrigated agriculture approximate the conditions which pertain in Egypt. In the work in Arizona two principal difficulties remain to be overcome. These are labor and the marketing of the crop. Cotton picking is a serious difficulty in a region where labor is scarce and wages high. The transportation problem is yet to be solved. But as the cotton brings a high price, it may be possible to ship it to the Pacific coast by rail, or even to Gulf ports and then by water to New England.



Crop of 1908. Crop of 1903.

FIG. 5.—MIT AFIFI SEED COTTON, SHOWING IMPROVEMENT BY SELECTION.

THE MAKING OF A NEW AMERICAN COTTON.

STERILIZING BUTTER.

STERILIZATION of butter is carried out by Messrs. Dornic and Daire, of Paris, by a new process.

The fact that butter becomes rancid prematurely and at a rapid rate is due to different kinds of microbes, as shown in the classic work of Sommaruga, Reimann and others, and they find more than ten kinds of microbes. Usually these originate rarely in the milk itself, but come from the water which is used for washing the vessels and for the butter washing. Such water is often contaminated by infiltrations from stables, etc., or from cheese establishments on the premises. The pasteurizing process which destroys the germs brought by the milk is of no avail if the butter is to be washed with water containing microbes which make it become rancid. The authors tried the various methods of sterilizing water in large quantities, seeing that we need five or six times the volume of the milk employed. None of them appear available except ozone treatment, and this requires too much skill to be used here. After the experiments of Messrs. Courmont and Nogier on sterilization of water by ultra-violet rays from a quartz mercury vapor lamp, the authors apply it in the present case. The apparatus is a wood tank lined throughout with glass and divided into four chambers by glass partitions of unequal height so as to give a stirring up of the water. This latter is an important part of the process. Through the cover are placed two quartz lamps, which, however, are not plunged into the water. Such apparatus gives 500 to 800 gallons per hour. Although the sterilization is not absolute, there is a great reduction in the number of microbes, and the results were very good for the preservation of the butter. To give an idea of the reduction in the number of microbes, it is stated that in one case the water contained 220 colonies per cubic centimeter, of which 15 were liquefying. After the treatment there were found but 20 colonies per cubic centimeter, and none of them liquefying. The microbes which liquefy gelatine, especially *B. fluorescens liquefaciens*, this being very frequent in water, are the most dangerous for butter, and the authors judge that the good results they obtain are due to their disappearance wholly or in great part. Specimens of butter treated as usual became rancid after eight days, while the same kind of butter when washed with the sterilized water was tasted after one month by competent persons, who were unable to distinguish it from fresh butter two or three days old. As a general rule, the authors claim to have increased the time of keeping butter by three weeks. These results bore upon operations on a large scale such as the daily production of 800 pounds of butter. No doubt we will not be able to use the ultra-violet rays for a direction action on the butter, as it is opaque in the first place, and again it quickly takes a smell and taste of suet when in contact with the ozone produced by the lamps. This is the same for cream and to some extent for milk, so that the method which we mentioned for sterilizing milk by the rays carried out at the Paris University is not likely to be of practical use.

MUSICAL SANDS IN CHILE.

By M. H. GRAY.

SOME few miles to the west of the town of Copiapo, in Chile, and, so far as my recollection of the locality carries me, about half a mile to the southward of the railway line, there is a tailing off of a ragged hill-range, which runs about north and south. In a ravine—it is too small to be called a valley—the sand which covers the greater part of that portion of Chile has, blown doubtless by the sea-breeze, been carried up the gully to which I refer, and lies there at a slope equal to the flowing angle of dry sand. The place is locally known by the name of "El Punto del Diablo," as, given conditions of wind and weather, which time did not allow me to study, a low moaning sound, varying in intensity, can be heard for quite a quarter of a mile away. Among the superstitious natives the place is avoided.

Thinking it worth a visit, I went there with the late Mr. Edwards, who was then the British Consul in that district. On our arrival we found that the sands were quite silent, but on making a glissade down the slope a gradually increasing "rumble" was heard, which increased in volume as the sand slid away before us. As the sound increased we were subjected to an undulatory movement, so decided that it was difficult to keep one's balance, and as we both had heard that this sand had swept over an old silver mine, there was a clear impression on the minds of both that the vibration might break in the roof of the old workings. I write of this experience for what it is worth. I do not know whether the ground under the sand was hollow or solid, and although I have ventured to theorize on the subject, as yet I have found no satisfactory solution of this, to me, quite unique experience.—Nature.

"English" Metal (métal anglais).—An alloy, consisting, according to Moussier, of 440 parts of tin, 10 parts copper, 1 part brass, 1 part sulphate of nickel, ½ part sulphate of bismuth, 4 parts antimony, and 1 part tungsten.

VISUALIZING THE ATOM.*—II.

HOW THE MODERN SCIENTIST COUNTS AND MEASURES ATOMS.

BY ERNEST RUTHERFORD.

Concluded from Supplement No. 1759, page 179.

THE study of the properties of ionized gases in recent years has led to the development of a number of important methods of determining the charge carried by the ion, produced in gases by α rays or the rays from radio-active substances. On modern views, electricity, like matter, is supposed to be discrete in structure, and the charge carried by the hydrogen atom set free by the electrolysis of water is taken as the fundamental unit of quantity of electricity. On this view, which is supported by strong evidence, the charge carried by the hydrogen atom is the smallest unit of electricity that can be obtained, and every quantity of electricity consists of an integral multiple of this unit. The experiments of Townsend have shown that the charge carried by a gaseous ion is, in the majority of cases, the same and equal in magnitude to the charge carried by a hydrogen atom in the electrolysis of water. From measurement of the quantity of electricity required to set free one gramme of hydrogen in electrolysis, it can be deduced that $Ne = 1.29 \times 10^{10}$ electrostatic units where N, as before, is the number of molecules of hydrogen in one cubic centimeter of gas, and e the charge carried by each ion. If e be determined experimentally, the value of N can at once be deduced from this relation.

The first direct measurement of the charge carried by the ion was made by Townsend in 1897. When a solution of sulphuric acid is electrolyzed, the liberated oxygen is found in a moist atmosphere to give rise to a dense cloud composed of minute globules of water. Each of these minute drops carries a negative charge of electricity. The size of the globules, and consequently the weight, was deduced with the aid of Stokes's formula by observing the rate of fall of the cloud under gravity. The weight of the cloud was measured, and, knowing the weight of each globule, the total number of drops present was determined. Since the total charge carried by the cloud was measured, the charge e carried by each drop was deduced. The value of e, the charge carried by each drop, was found by this method to be about 3.0×10^{-10} electrostatic unit. The corresponding value of N is about 4.3×10^{19}.

We have already referred to the method discovered by C. T. R. Wilson of rendering each ion visible by the condensation of water upon it by a sudden expansion of the gas. The property was utilized by Sir Joseph Thomson to measure the charge e carried by each ion. When the expansion of the gas exceeds a certain value, the water condenses on both the negative and positive ions, and a dense cloud of small water drops is seen. J. J. Thomson found $e = 3.4 \times 10^{-10}$, H. A. Wilson $e = 3.1 \times 10^{-10}$, and Millikan and Begeman 4.06×10^{-10}. The corresponding values of N are 3.8, 4.2 and 3.2×10^{19} respectively. This method is of great interest and importance, as it provides a method of directly counting the number of ions produced in the gas. An exact determination of e by this method is, however, unfortunately beset with great experimental difficulties.

Moreau has recently measured the charge carried by the negative ions produced in flames. The values deduced for e and N were respectively 4.3×10^{-10} and 3.0×10^{19}.

We have referred earlier in the paper to the work of Ehrenhaft on the Brownian movement in air shown by ultra-microscopic dust of silver. In a recent paper (1909) he has shown that each of these particles carries a positive or negative charge. The size of each particle was measured by the ultra-microscope, and also by the rate of fall under gravity. The charge carried by each particle was deduced from the measured mass of the particle, and its rate of movement in an electric field. The mean value of e was found to be 4.6×10^{-10}, and thus N becomes 2.74×10^{19}.

A third important method of determination of N from radio-active data was given by Rutherford and Geiger in 1908. The charge carried by each α particle expelled from radium was measured by directly determining the total charge carried by a counted number of α particles. The value of the charge on each α particle was found to be 9.3×10^{-10}. From consideration of the general evidence, it was concluded that each α particle carries two unit positive charges, so that the value of e becomes 4.65×10^{-10}, and of N 2.77×10^{19}. This method is deserving of considerable confidence as the measurements involved are direct and capable of accuracy.

The methods of determination of e, so far explained, have depended on direct experiment. This discussion would not be complete without a reference to an important determination of e from theoretical considerations by Planck. From the theory of the distribution of energy in the spectrum of a hot body, Planck found that $e = 4.69 \times 10^{-10}$, and $N = 2.80 \times 10^{19}$ For reasons that we cannot enter into here, this theoretical deduction must be given great weight.

When we consider the great diversity of the theories and methods which have been utilized to determine the values of the atomic constants e and N, and the probable experimental errors, the agreement among the numbers is remarkably close. This is especially the case in considering the more recent measurements by very different methods, which are far more reliable than the older estimates. It is difficult to fix on one determination as more deserving of confidence than another; but I may be pardoned if I place some reliance on the radio-active method previously discussed, which depends on the charge carried by the α particle. The value obtained in this way is not only in close agreement with the theoretical estimate of Planck, but is in fair agreement with the recent determinations by several other distinct methods. We may consequently conclude that the number of molecules in a cubic centimeter of any gas at standard pressure and temperature is about 2.77×10^{19}, and that the value of the fundamental unit of quantity of electricity is about 4.65×10^{-10} electrostatic units. From these data it is a simple matter to deduce the mass of any atom whose atomic weight is known, and to determine the values of a number of related atomic and molecular magnitudes.

There is now no reason to view the values of these fundamental constants with skepticism, but they may be employed with confidence in calculations to advance still further our knowledge of the constitution of atoms and molecules. There will no doubt be a great number of investigations in the future to fix the values of these important constants with the greatest possible precision; but there is every reason to believe that the values are already known with reasonable certainty, and with a degree of accuracy far greater than it was possible to attain a few years ago. The remarkable agreement in the values of e and N, based on so many different theories, of itself affords exceedingly strong evidence of the correctness of the atomic theory of matter, and of electricity, for it is difficult to believe that such concordance would show itself if the atoms and their charges had no real existence.

There has been a tendency in some quarters to suppose that the development of physics in recent years has cast doubt on the validity of the atomic theory of matter. This view is quite erroneous, for it will be clear from the evidence already discussed that the recent discoveries have not only greatly strengthened the evidence in support of the theory, but have given an almost direct and convincing proof of its correctness. The chemical atom as a definite unit in the subdivision of matter is now fixed in an impregnable position in science. Leaving out of account considerations of etymology, the atom in chemistry has long been considered to refer only to the smallest unit of matter that enters into ordinary chemical combination. There is no assumption made that the atom itself is indestructible and eternal, or that methods may not ultimately be found for its subdivision into still more elementary units. The advent of the electron has shown that the atom is not the unit of smallest mass of which we have cognizance, while the study of radio-active bodies has shown that the atoms of a few elements of high atomic weight are not permanently stable, but break up spontaneously with the appearance of new types of matter. These advances in knowledge do not in any way invalidate the position of the chemical atom, but rather indicate its great importance as a subdivision of matter whose properties should be exhaustively studied.

The proof of the existence of corpuscles or electrons with an apparent mass very small compared with that of the hydrogen atom, marks an important stage in the extension of our ideas of atomic constitution. This discovery, which has exercised a profound influence on the development of modern physics, we owe mainly to the genius of the president of this association. The existence of the electron as a distinct entity is established by similar methods and with almost the same certainty as the existence of individual α particles. While it has not yet been found possible to detect a single electron by its electrical or optical effect, and thus to count the number directly as in the case of the α particles, there seems to be no reason why this should not be accomplished by the electric method. The effect to be anticipated for a single β particle is much smaller than that due to an α particle, but not too small for measurement. In this connection it is of interest to note that Regener has observed evidence of scintillations produced by the β particles of radium falling on a screen of platinocyanide of barium, but the scintillations are too feeble to count with certainty.

Experiment has shown that the apparent mass of the electron varies with its speed, and, by comparison of theory with experiment, it has been concluded that the mass of the electron is entirely electrical in origin and that there is no necessity to assume a material nucleus on which the electrical charge is distributed. While there can be no doubt that electrons can be released from the atom or molecule by a variety of agencies and, when in rapid motion, can retain an independent existence, there is still much room for discussion as to the actual constitution of electrons, if such a term may be employed, and of the part they play in atomic structure. There can be little doubt that the atom is a complex system, consisting of a number of positively and negatively charged masses which are held in equilibrium mainly by electrical forces; but it is difficult to assign the relative importance of the rôle played by the carriers of positive and negative electricity. While negative electricity can exist as a separate entity in the electron, there is yet no decisive proof of the existence of a corresponding positive electron. It is not known how much of the mass of an atom is due to electrons or other moving charges, or whether a type of mass quite distinct from electrical mass exists. Advance in this direction must be delayed until a clearer knowledge is gained of the character and structure of positive electricity and of its relation to the negative electron.

The general experimental evidence indicates that electrons play two distinct rôles in the structure of the atom, one as lightly attached and easily removable satellites or outliers of the atomic system, and the other as integral constituents of the interior structure of the atom. The former, which can be easily detached or set in vibration, probably play an important part in the combination of atoms to form molecules, and in the spectra of the elements; the latter, which are held in place by much stronger forces, can only be released as a result of an atomic explosion involving the disintegration of the atom. For example, the release of an electron with slow velocity by ordinary laboratory agencies does not appear to endanger the stability of the atom, but the expulsion of a high-speed electron from a radio-active substance accompanies the transformation of the atom.

The idea that the atoms of the elements may be complex structures, made up either of lighter atoms or of the atoms of some fundamental substance, has long been familiar to science. So far no direct evidence has been obtained of the possibility of building up an atom of higher atomic weight from one of lower atomic weight, but in the case of the radio-active substances we have decisive and definite evidence that certain elements show the converse process of disintegration. It may be significant that this process has only been observed in the atoms of highest atomic weights, like those of uranium, thorium and radium. With the exception possibly of potassium, there is no reliable evidence that a similar process takes place in other elements. The transformation of the atom of a radio-active substance appears to result from an atomic explosion of great intensity in which a part of the atom is expelled with great speed. In the majority of cases, an α particle or atom of helium is ejected, in some cases a high-speed electron, while a few substances are transformed without the appearance of a detectable radiation. The fact that the α particles from a simple substance are all ejected with an identical and very high velocity suggests the probability that the charged helium atom before its expulsion is in rapid orbital movement in the atom. There is at present no definite evidence of the causes operative in these atomic transformations.

Since in a large number of cases the transforma-

* Abstracted from a paper read before the British Association for the Advancement of Science.

tions of the atoms are accompanied by the expulsion of one or more charged atoms of helium, it is difficult to avoid the conclusion that the atoms of the radio-active elements are built up, in part at least, of helium atoms. It is certainly very remarkable and may prove of great significance, that helium, which is regarded from the ordinary chemical standpoint as an inert element, plays such an important part in the constitution of the atoms of uranium, thorium, and radium.

The study of radio-activity has not only thrown great light on the character of atomic transformations, but it has also led to the development of methods for detecting the presence of almost infinitesimal quantities of radio-active matter. It has already been pointed out that two methods—one electrical, the other optical—have been devised for the detection of a single α particle. By the use of the optical or scintillation method, it is possible to count with accuracy the number of α particles when only one is expelled per minute. It is not a difficult matter, consequently, to follow the transformation of any radio-active substance in which only one atom breaks up per minute, provided that an α particle accompanies the transformation. In the case of a rapidly changing substance like the actinium emanation, which has a half period of 3.7 seconds, it is possible to detect with certainty the presence, if not of a single atom, at any rate of a few atoms, while the presence of a hundred atoms would in some cases give an inconveniently large effect. The counting of the scintillations affords an exceedingly powerful and direct quantitative method of studying the properties of radio-active substances which expel α particles. Not only is it a simple matter to count the number of α particles which are expelled in any given interval, but it is possible, for example, by suitably arranged experiments to decide whether one, two, or more α particles are expelled at the disintegration of a single atom.

The possibility of detection of a single atom of matter has opened up a new field of investigation in the study of discontinuous phenomena. For example, the experimental law of transformation of radio-active matter expresses only the average rate of transformation, but by the aid of the scintillation or electric method it is possible to determine directly by experiment the actual interval between the disintegration of successive atoms and the probability law of distribution of the α particles about the average value.

Quite apart from the importance of studying radio-active changes, the radiations from active bodies provide very valuable information as to the effects produced by high velocity particles in traversing matter. The three types of radiation, the α, β, and γ rays, emitted from active bodies, differ widely in character and their power of penetration of matter. The α particles, for example, are completely stopped by a sheet of note paper, while the γ rays from radium can be easily detected after traversing twenty centimeters of lead. The differences in the character of the absorption of the radiations are no doubt partly due to the difference in type of the radiation and partly due to the differences of velocity.

The character of the effects produced by the α and β particles is most simply studied in gases. The α particle has such great energy of motion that it plunges through the molecules of the gas in its path, and leaves in its train more than a hundred thousand ionized or dissociated molecules. After traversing a certain distance, the α particle suddenly loses its characteristic properties and vanishes from the ken of our observational methods. It no doubt quickly loses its high velocity, and after its charge has been neutralized becomes a wandering atom of helium. The ionization produced by the α particle appears to consist of the liberation of one or more slow velocity electrons from the molecule, but in the case of complex gases there is no doubt that the act of ionization is accompanied by a chemical dissociation of the molecule itself, although it is difficult to decide whether this dissociation is a primary or secondary effect. The chemical dissociation produced by α particles opens up a wide field of investigation, on which, so far, only a beginning has been made.

The β particle differs from the α particle in its much greater power of penetration of matter, and the very small number of molecules it ionizes compared with the α particle traversing the same path in the gas. It is very easily deflected from its path by encounters with the gas molecules, and there is strong evidence that, unlike the α particle, the β particle can be stopped or entrapped by a molecule when traveling at a very high speed.

When the great energy of motion of the α particle and the small amount of energy absorbed in ionizing a single molecule are taken into consideration, there appears to be no doubt that the α particle, as Bragg pointed out, actually passes through the atom, or rather the sphere of action of the atom which lies in its path. There is, so to speak, no time for the atom to get out of the way of the swiftly moving α particle, but the latter must pass through the atomic system. On this view, the old dictum, no doubt true in most cases, that two bodies cannot occupy the same space, no longer holds for atoms of matter if moving at a sufficiently high speed.

There would appear to be little doubt that a careful study of the effects produced by the α or β particle in passing through matter will ultimately throw much further light on the constitution of the atom itself. Work already done shows that the character of the absorption of the radiations is intimately connected with the atomic weights of the elements and their position in the periodic table. One of the most striking effects of the passage of β rays through matter is the scattering of the β particles, i. e., the deflection from their rectilinear path by their encounters with the molecules. It was for some time thought that such a scattering could not be expected to occur in the case of the α particles in consequence of their much greater mass and energy of motion. The recent experiments of Geiger, however, show that the scattering of the α particles is very marked, and is so great that a small fraction of the α particles, which impinge on a screen of metal, have their velocity reversed in direction and emerge again on the same side. This scattering can be most conveniently studied by the method of scintillations. It can be shown that the deflection of the α particle from its path is quite perceptible after passing through very few atoms of matter. The conclusion is unavoidable that the atom is the seat of an intense electric field, for otherwise it would be impossible to change the direction of the particle in passing over such a minute distance as the diameter of a molecule.

In conclusion, I should like to emphasize the simplicity and directness of the methods of attack on atomic problems opened up by recent discoveries. As we have seen, not only is it a simple matter, for example, to count the number of α particles by the scintillations produced on a fine zinc sulphide screen, but it is possible to examine directly the deflection of an individual particle in passing through a magnetic or electric field, and to determine the deviation of each particle from a rectilinear path due to encounters with molecules of matter. We can determine directly the mass of each α particle, its charge, and its velocity, and can deduce at once the number of atoms present in a given weight of any known kind of matter. In the light of these and similar direct deductions, based on a minimum amount of assumption, the physicists have, I think, some justification for their faith that they are building on the solid rock of fact, and not, as we are often so solemnly warned by some of our scientific brethren, on the shifting sands of imaginative hypothesis.

THERMO-PENETRATION.

A NEW SYSTEM OF ELECTRO-THERAPEUTICS.

BY O. NAIRZ.

Two Vienna physicians, Von Preys and Von Bernd, have devised a new method of electrical therapeutics, which they have named thermo-penetration. For a number of years, especially in France, glow discharges from highly-charged coils have been used for medical purposes. For example, the healing of the wounds made by the excision of superficial cancers and other growths has been expedited by a process called fulguration, in which the wounds receive the glow discharges which are emitted by the secondary circuit of an induction coil when the primary circuit is traversed by the rapidly-alternating discharge of a condenser charged to a high potential, and the coil is attuned to resonance with the oscillating condenser discharge. In a common form of apparatus the secondary coil, containing many turns of fine wire, can be moved so as to inclose a greater or smaller proportion of the primary coil coarse wire. The protruding part of the primary coil is left bare and receives the spark discharge of four Leyden jars, which are charged by an auxiliary induction coil. The discharge of the Leyden jars is composed of about 100 partial discharges, alternately positive and negative, which follow each other at intervals of one-millionth of a second, the entire phenomenon occupying 1/10,000 second. This alternating current of brief duration and very high frequency, flowing through the primary circuit of the induction coil, induces an alternating current of the same duration and frequency and of much higher voltage, in the secondary circuit.

When the movable secondary coil has been adjusted to the position of resonance the outer end of the wire emits a flamelike discharge, resembling St. Elmo's fire, which is allowed to play upon the skin of the patient. The intensity of the effect can be regulated by making the resonance more or less perfect.

When the discharge is received directly by the skin some local pain is experienced, but the discharge is scarcely felt when it is received by a piece of metal held in the hand. Evidently the cells are unable to react quickly enough to feel the rapidly alternating current, just as the ear is unable to perceive sound waves of very high pitch.

The beneficial effects of fulguration are due to superficial burning or heating, but thermo-penetration heats the internal tissues. The human body, like any other conductor, is heated by electric currents which pass through it, the rate of generation of heat being proportional to the electrical resistance of the part of the body involved, multiplied by the square of the current strength. The direct current cannot be employed to heat the bodily tissues, because a current of 0.1 ampere (about one-fifth the current used in a 16-candle-power incandescent lamp) would, in most cases, cause death. The alternating currents which are used in lighting and transmission of power are still more dangerous, but the very rapidly-alternating currents which are produced by the methods described in this article are comparatively safe, for the reason already given, and they can be borne in considerably greater strength.

Physicians have long known that many physiological processes are favorably affected by increase of temperature. Such increase occurs spontaneously in fever, which is a natural curative process, and by which pain is alleviated, injurious micro-organisms are destroyed and eliminated, and other beneficial results are accomplished by the abnormally rapid flow of blood. Until recently it was impossible to increase the bodily temperature effectively by artificial means, as the hottest air and vapor baths that can be borne raise the temperature of the blood to barely 0.1 deg. F. above the normal.

The Vienna physicians employed, in their system of thermo-penetration, the so-called continuous and undamped rapid electrical oscillations produced by Poulsen's method. These oscillations are inconvenient in use and require for their production a direct current of from 220 to 440 volts, which is seldom obtainable. Siemens and Halske have constructed a simple apparatus by which essentially the same results are obtained more conveniently. A condenser, composed of alternate sheets of tinfoil and paper, is charged by a small sparking coil, and discharged through a new and peculiarly effective spark-gap to the primary circuit of an induction coil, as in the fulguration apparatus described above.

An oscillating current, the strength of which can be regulated by adjusting the relative positions of the two coils, is induced in the secondary coil, the terminals of which are placed in contact with the part of the body which is to be heated. Thus the current flows into the body directly, and not through an air space, as in fulguration. The patient feels no pain, but only an agreeable and beneficial warmth, although the strength of the current may be as high as ½ ampere. The skin, which can not endure a temperature higher than 120 deg. F., gives the indication for the limit of current strength. The apparatus includes devices by which the strength of the primary current and the frequency of interruption of the charging coil can be measured and controlled.

Although this process of thermo-penetration has been in use only a very short time it has already proved successful in numerous cases. Its employment appears especially promising in cancer. Cancerous tissue is a better electrical conductor than healthy tissue, and it is therefore very strongly heated by the current.—Prometheus.

TEETH AND THEIR SUBSTITUTES.*

NATURE'S FOOD CRUSHERS.

BY W. P. PYCRAFT.

THOUGH Nature evidently meant the vertebrates to be a tooth-bearing race, this design has been by no means rigidly adhered to, as many creatures of very different orders have been permitted, so to speak, to adopt various substitutes therefore.

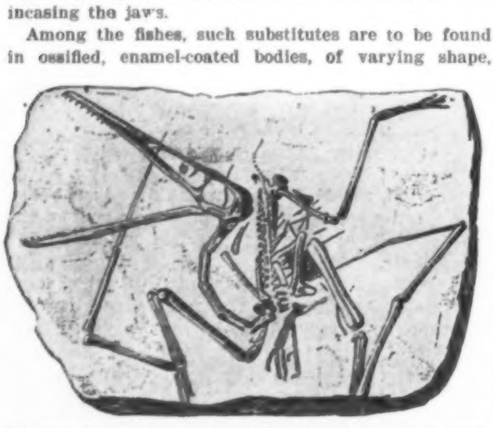
The earliest tooth bearers among the limb-bearing vertebrates are to be found among the shark tribe—using this term in a wide sense—and it is here that we must look for the origin of teeth, searching, if not "with forks and hope," after the fashion prescribed for shark hunting, at any rate with scalpel and microscope.

Skull and lower jaw of Odontopteryx toliapica, with bony denticles on jaws, from the London Clay of Sheppey. (2/3 nat. size.)

Properly conducted such a search reveals the truly astonishing fact that the earliest, most primitive forms of teeth are really nothing more than modified scales. In the sharks, it may be remembered, as in the common dog-fish for example, the surface of the skin is incased in a mosaic of tiny, closely fitting ossicles, bearing each an enamel-covered spine, and skin so covered was at one time in great request for commercial purposes, being known as shagreen. In the embryo dog-fish it will be found that the skin covering the jaws is perfectly continuous with that of the body and is similarly incased. Later, however, the scales in this region become enlarged and assume the characteristic form of teeth. Among the sharks this dentition has become modified in many ways, the most striking of all being the evolution of "pavement teeth"—broad, flat plates, symmetrically disposed, and used for crushing purposes.

But we are not concerned here with the various forms of teeth, so much as the substitutes therefor, which, for one cause or another, have been adopted by different groups of vertebrates. Suffice it to say, then, that the primitive teeth, imbedded as it were in the skin and stretched over the rod-like cartilaginous jaws, gradually assume a more intimate relation therewith, and sending down "fangs" became rooted in the jaw; while, at the same time, the covering of the body has gradually assumed other forms, so that, among the higher fishes and the rest of the vertebrates, all evidence of this peculiar origin has become obliterated. Furthermore, among each of the great groups of vertebrates more or fewer members have discarded teeth altogether, so far as the armature of the jaws is concerned, replacing these either with tooth-like bodies in some other part of the mouth, or with horny sheaths incasing the jaws.

Among the fishes, such substitutes are to be found in ossified, enamel-coated bodies, of varying shape,



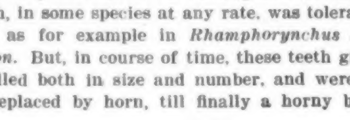
The almost complete skeleton of Pterodactylus antiquus (Sommerring), from the Lithographic Stone, Eichstadt, Bavaria (½ nat. size), showing the reduction of the teeth.

situated in the throat and known as pharyngeal teeth, as, for example, in the carps. On the other hand, it may be mentioned, some fishes have gone to the other extreme, and have, as if to secure themselves against all danger of toothlessness, devised the plan of welding all the teeth in the jaws into a solid mass, and fusing this inseparably with the jaws! And this perhaps to avoid the degradation of false teeth in the shape of the horny sheaths about which we are presently to speak, for in function these dental masses are the equivalents. No fish seems to have descended to such subterfuge.

Among the amphibia horny bosses simulating and performing the work of teeth are commonly developed during larval life, and are either replaced by minute teeth by the adult, or for the rest of life's journey they remain toothless as in the common toad.

But the amphibia, as befits their mode of life, seem to wobble a good deal in this matter of teeth; they halt, as it were, between two opinions. For, while some are toothless, others carry a few fine denticles on both upper and lower jaws, or they may be borne only on the upper or lower jaw respectively. They may in addition to these teeth on the jaws have teeth studding the roof of the mouth, or these last may be the only teeth in the head. Finally, there are some which seem to have contemplated the introduction of horny teeth during adult life, since the skin covering the roof of the mouth is therein thrown into ridges of hardened skin which may be "denticulated."

The reptiles, as befits their higher grade, are less uncertain in this matter. Among existing species the tortoises and turtles alone have discarded teeth, the jaws being incased, as in birds, in horny sheaths. That their ancestors were tooth-bearing creatures there can be little doubt; but to-day not even embryonic traces remain. We can reckon the more certainly on the truth of this conjecture since among extinct reptiles some very remarkable evolutionary phases in the substitution of teeth by horny casements for the jaws are to be met with. And nowhere is this more beautifully illustrated than in those old flying dragons—the pterodactyls. As may be seen in our text-figures the armature of teeth, in some species at any rate, was tolerably formidable, as for example in *Rhamphorynchus* and *Dimorphodon*. But, in course of time, these teeth gradually dwindled both in size and number, and were as gradually replaced by horn, till finally a horny beak



Skull and lower jaw of Ichthyornis victor, from the Cretaceous of Kansas, U. S. A. (½ nat. size. After Marsh.)

as in birds had come into being. A glance at the illustrations given herewith will enable the nature of this change to be realized more easily than a mere description thereof.

But this exchange, it is to be remembered, took place among many groups of reptiles, so far as the evidence goes, not in the least related. Among the dinosaurs, for instance, the same transformation took place, and, similarly, the change was gradual. But while among the pterodactyls the premaxillary teeth seem to have been the last to go, among the dinosaurs, in many cases, these seem to have been the first to disappear. *Ceratosaurus* may well serve as an example of what these creatures attained to in the matter of teeth, though even here, it will be remarked, the armature of the lower jaw is on the wane. And the same is true indeed of the upper jaw in so far as the hindmost teeth are concerned, but the decline is here less marked. In the giant *Diplodocus* all the teeth but a few skewer-like pegs in the front of the jaw have vanished completely, while in the *Iguanodon* the hindmost teeth are retained and the front teeth replaced by a beak-like sheath.

The pterodactyls and the dinosaurs were, however, as we have already remarked, not the only groups of these extinct reptilia which, more or less completely, contrived to exist without teeth. Among these old "fish-lizards," the ichthyosauria, for example, a beautiful series in the reduction of the teeth is met with, ending with the jaws of *Ophthalmosaurus*, wherein the adult was toothless, or at most, in some individuals, retained but a few minute teeth confined to the front of the jaw.

From the reptile to the bird is an easy step; and one would expect the ancestral birds to have tooth-bearing jaws. In the earliest known bird, *Archæopteryx*, well-developed teeth are met with; and the same is true of the cretaceous *Ichthyornis* and *Hesperornis*. But in the two last-named, both aquatic and fish-eating types, the toothless condition which was to prevail among modern birds was foreshadowed, inasmuch as the premaxillary portion of the jaw—the front portion of the upper jaw—was toothless and sheathed in horn. It would almost seem indeed as though these teeth were discarded grudgingly, at any rate among the fish-eating birds; since in another fossil—*Odontopteryx toliapicus*—though teeth are wanting the bony sides of the jaw developed tooth-like, angular bosses of bone which were incased in horn. And to this day certain fish-eating ducks adopt a similar expedient, though the bony cores to such horn "teeth" are wanting. Serrated edges to the beak-sheath are developed indeed among many groups of birds, some of which are certainly not fish-eaters. In the darter, which is piscivorous, teeth are replaced by short needle-like spines along the edges of the jaw, and a similar device

Right lateral view of the skull of Rhamphorynchus, from the Lithographic Stone of Eichstadt, Bavaria, to show the armature of teeth.

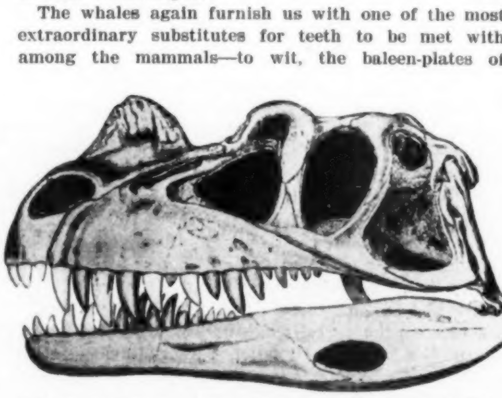
obtains among the insect-eating sun-birds.

Since birds retain many vestiges of ancestral and now obsolete and discarded structural characters, it is but natural to suppose that some trace of the now absent teeth should appear in the embryo. According to some authorities such vestiges are to be met with in the embryos of parrots. But the evidence so far submitted does not bear out the interpretation placed upon it. Nevertheless it is highly probable that such evidence will yet come to light, and we venture to prophesy that it will be furnished by the tinamous and ostriches. The present writer, indeed, long since drew attention to certain toothlike structures in the jaws of young tinamous, and hopes in the near future to demonstrate their true character.

Our survey has now brought us to the mammalia, which in point of interest in this matter of teeth and their substitutes exceed all the other vertebrates.

Primitively tooth-bearing, some have now become absolutely toothless, as in the anteaters and echidna; while in others the number of teeth has been greatly reduced. And this not by any sudden process, but as it were by slow starvation, each tooth as it passes the point of usefulness disappearing by a slow process of absorption. The last stages of their degeneration are carried out in secret as it were, the developing tooth being, so to speak, smothered before it cuts the gum. As a study in evolution by atrophy, it would be impossible to find a more striking series of examples than is to be furnished by the present-day whales. Beginning with the beluga, wherein this reduction is already far advanced, only nine teeth remaining on each side of the upper and lower jaws, we pass to the grampus with from three to seven teeth in the lower jaw only, and thence to the narwhal with but two in the form of the well-known tusks—generally only one of these is developed.

The whales again furnish us with one of the most extraordinary substitutes for teeth to be met with among the mammals—to wit, the baleen-plates of



Left lateral view of skull of Ceratosaurus nasicornis (Marsh), from the Upper Jurassic, North America. (1/6 nat. size. After Marsh.)

"whalebone" whales. And it is therefore all the more remarkable that in this embryonic state the jaws contain their full complement of teeth, though these never cut the gum!

Finally we come to the remarkable case of the duck-billed platypus (*Ornithorhynchus*). As is implied by its popular name, the jaws of this creature bear a very striking resemblance to the beak of a duck, though really much more flattened than in any anserine bird. But, be that as it may, they are unquestionably bird-like, not only in shape, but in the absence of teeth. If the mouth be opened, however, there will be found

* Knowledge and Scientific News.

within two pairs of saucer-shaped horny pads, attached to the upper and lower jaws respectively. These serve as crushing pads for the trituration of small mollusca on which the animal feeds; and, since the creature is a mammal, these pads are obviously substitutes for teeth. So much, indeed, was always taken for granted. But in 1888, Prof. Poulton, of Oxford, actually discovered teeth in the jaws of an embryo, and later Mr. Oldfield Thomas, of the British Museum, had the good fortune to discover these teeth actually in use in immature animals. He further showed that they remained functional till worn out, by which time the horny

Left lateral view of skull of Pteranodon longiceps (Marsh), from the Cretaceous of North America (1/12 nat. size), to show the horny beak.

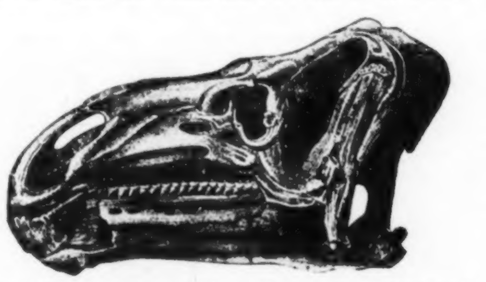
pads are large and hard enough to take their place!

The peculiarities of the teeth herein discussed have purposely been omitted, for these, as well as the manner of their use, seem to have no bearing on the law of survival. That is to say, animals of all grades, carnivorous or vegetivorous, show the same phases of evolution and devolution. But there seems to be some correlation between toothlessness and the persistence in time of the groups so denuded. Thus the earliest dinosaurs, ichthyosaurs, and pterodactyls, like the earliest birds, all have the jaws armed with teeth, and all in course of time replaced these teeth by horny casements. And this seems to be true also of the mammals, though to a less marked degree. It remains now for someone to read us the answer to this riddle.

RADIUM EMANATION AND THE DECOMPOSITION OF WATER.

At the end of last year Sir William Ramsay noticed an apparent decay of radium. He had sealed up some radium bromide in a bulb together with water—i. e., salt and water in the same bulb—and had observed a regular evolution of gas, hydrogen and oxygen from the water, proceeding at the rate of 30 cubic centimeters of gas per week. This evolution went on for nine months, when it ceased almost entirely. Sir William Ramsay concluded that either the radium salt had lost its capacity for decomposing water, or that the velocity of the reverse action, the recombination of oxygen and hydrogen to water, predominated over that of the decomposition. If the former assumption should prove true, then there might similarly be a time limit to the evolution of heat by radium and to the emission of rays in general. This abnormal cessation of the decomposition of water by radium is questioned by A. Debierne, one of the first workers in this field, in a communication recently presented to the French Academy of Sciences. The phenomena are very complicated, however, and it should be mentioned that, according to Rutherford and Tuomikoski, the rate of decay of the emanation is irregular.

The interesting feature in Debierne's new experiments is that he decomposed the water by the direct action of rays, keeping the radium salt and the water in separate glass vessels. The radium salt, he points out, emits α, β, and γ rays; the α rays would be absorbed by the glass walls of the vessels, and the β and γ rays would hence, in his experiment, directly affect the decomposition of the water, which seemed to continue at a uniform rate. The rate remained constant in his experiment, which extended over many months,

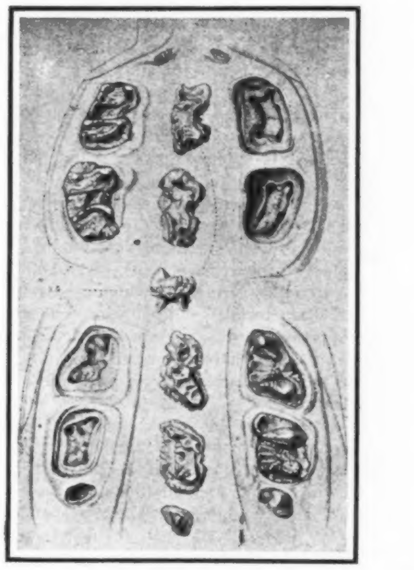


Left lateral aspect of skull of Iguanodon Bernissartensis (Boulenger), from the Wealden of Bernissart, Belgium (much reduced). The anterior aperture in the skull is the narer (nostril), the middle one the orbit, and the large posterior one, the lateral temporal fossa.

but there was finally a slight diminution in the rate, which might be accounted for in the following way: There is always an excess of hydrogen in the liberated gas, as Ramsay had already noticed; part of the oxygen, Debierne remarks, must therefore be absorbed by the water, oxides would probably be formed, and these oxides might in their turn absorb some of the hydrogen, so that the rate of gas production would apparently diminish. According to this reasoning, we are not obliged to believe in a material alteration of the rate in the course of time, which would be contrary to the general assumption of a constancy in radio-active phenomena. The mean rate of gas production is, according to Debierne, 0.115 cubic centimeter per gramme of radium per day—very much smaller than Ramsay's figure—and it would appear that about 1 per cent of the total radiant energy is absorbed by the water and transformed into chemical energy.

In a subsequent paper published in the Comptes Rendus, Debierne deals with the purification of radium emanation. Oxygen, hydrogen, carbon oxides, and nitrogen were removed from the emanation by successive treatments with heated metallic copper, copper oxide, phosphoric oxide, fused potash, and heated metallic lithium; the purified emanation was then liquefied between —175 and —150 deg. C., and a residue containing some helium, together with emanation, was pumped off. The liquefied emanation was finally quite free from neon and helium, and the mean volume of emanation in equilibrium with 1 gramme of radium was found to be 0.58 cubic millimeter, while Rutherford had recently found, by a different method, 0.57 cubic millimeter. The agreement with Rutherford as to the half-period of the emanation—3.81 days according to Debierne, 3.75 days according to Rutherford—is equally remarkable. Debierne's emanation yielded spontaneous electric discharges, attributed to the accumulation of electric charges by the α and β particles in the insulating vessel, which, when made of lead glass, turned violet.

Rutherford's first-mentioned value of 0.57 cubic millimeter was defined by assuming that one atom of radium emits one α particle, and then becomes one atom of emanation; the number of α particles emitted per second was known from the experiments of Rutherford and Geiger. According to Ramsay and Cameron, 1 gramme of radium should yield 7.07 cubic milli-



Palate of Duck-billed Platypus (after Poulton), showing the teeth in position, on the roof of the mouth (left-hand top figure), and in the lower jaw (lower figure, right-hand), the horny pads which succeed them show the sockets of the displaced teeth, seen, from their roots, down the middle of the picture.

meters (instead of 0.57) of emanation; and Rutherford considers that Ramsay's emanation contained 80 per cent of foreign matter. One of these foreign substances, very difficult to remove or to keep out, is carbon dioxide, which, it will be remembered, Ramsay found in several of his experiments on thorium emanation; this observation induced him to suggest a degradation of thorium into carbon. By exercising the greatest care, lubricating his stop-cocks with phosphoric acid, and making the emanation stand for twenty-four hours at the time over potassium hydroxide, Rutherford finally obtained a radium emanation which hardly showed the spectrum of carbon dioxide any longer, while bright lines (probably of the emanation itself) were seen. When the emanation was left for eleven days in its capillary tube, the volume of the emanation increased again, and the bright lines of helium then became quite striking.

We may also refer to a further paper by E. Rutherford and T. Royds, published in the Philosophical Magazine, like several others of their communications. The object of this research was to prove that the α particle really consists of an atom of helium plus a positive charge. The purified radium emanation was compressed in a capillary tube, whose glass walls, 0.01 millimeter in thickness, would be impermeable to helium, but would allow the α particle, as well as radium A and radium C to pass into the annular space between the capillary and an outer tube of stout glass. The gas collecting in this outer tube was spectroscopically examined. After twenty-four hours no trace of helium could be detected in that gas; but after six days the helium lines were distinct. That helium, Rutherford suggests, must have been formed by the α particles which had traversed the inner capillary tube and which had slowly lost their charge. From other experiments, in which the outer glass tube was replaced by a cylinder of lead foil, it would further appear that the α particles were driven into the outer glass, and slowly given up again by the glass, while they would more readily escape from the lead; hence the slow appearance of the helium in the jacket.

That Rutherford and Royds question the transformation of radium emanation into neon, which had been suggested by Cameron and Ramsay in their transmutation experiments, has already been mentioned in con-

Skull and lower jaw of Archæopteryx siemensi, showing teeth, from the Lithographic Stone (Upper Jurassic) of Eichstadt, Bavaria. (Nat. size. After Dames. Original in Berlin Museum.)

nection with our reports on the Dublin meeting of the British Association last year. Particulars of the experiments on which they base their objections have since been published.

Leakage of air into glass apparatus which are worked for weeks and months is always likely, and Rutherford and Royds find that if only 1/5 cubic centimeter of air had found its way into Ramsay's apparatus, the flashing up of the neon line noticed by Ramsay would be accounted for. We may hence sum up that the production of helium from radium must be accepted, but that the other suggested transmutations have not been confirmed. The exceeding difficulty of such gas isolation experiments is well brought out by some quite recent researches of Franz Fischer, of Berlin. He prepared argon from air with the aid of calcium carbide (which binds the nitrogen), liquefied it, found it pure, and exposed the liquid argon to the spark or arc discharge with electrodes of cadmium (and other metals); but the apparent argon compound thus produced proved to be cadmium nitride. Some nitrogen had evidently leaked into the apparatus.—Engineering.

THE SENSITIVENESS OF DYES TO LIGHT.*

In the course of some experiments on the use of the ordinary dyes for photographic light-filters, observations were made of the permanency of the coloring matters. It was found that gelatine films which had been stained with chemically pure dyes made in the Hoescht works, and selected by Dr. E. Konig, showed a high degree of permanency, inasmuch as they could be exposed for an hour at a time in direct sunlight, without suffering the slightest perceptible alteration. But a quite different action was noticed with these same dyes when the films contained a relatively small proportion of glycerine. Addition to this substance, which might be presumed to have been quite inactive, greatly affected the permanency of the dyes toward light. Thus its action was very noticeable in the case of methylene blue, pheno-saffranine, and scarlet, less so in the case of crystal-violet and rose Bengal, and apparently *nil* in the case of patent-blue, echt-rot, and tartrazine. Using 10 grammes of gelatine and 3 cubic centimeters of glycerine, films of methylene-blue may be made which become completely colorless within an hour when exposed to direct sunlight, while the same film, without glycerine, undergoes no change whatever, exposure under a paper scale built up in gradation strips showing that by the addition of glycerine the sensitiveness of the dye is increased from

Lateral view of skull of Diplodocus longus (Marsh), from the "Atlantosaurus" beds (Upper Jurassic), near Canon City, Colorado, North America. (1/6 nat. size.)

100 to 1,000 times. Addition of other substances, such as salts of arsenic acid, allow of the sensitiveness being still further increased, so that an exposure of a few minutes in sunlight leads to a complete bleach-out action. In this case the addition of glycerine is so slight that the film may be said to dry, having no sign of dampness nor feeling of stickiness.

By these methods colored prints on paper can be prepared, although, unfortunately, they have the property that the parts bleached in the light rapidly reassume their original blue color. If a print of this kind is

* A note in the Wiener Mitteilungen for the translation of which we are indebted to the British Journal of Photography.

kept for a time in the dark, of course, the image disappears, particularly in the presence of moisture, the film becoming again of a uniform blue color, as it was before exposure.

It is noticeable that addition of copper salts may be employed to retard this bleach-out action of dyed films containing glycerine. If to the above-mentioned mixture of glycerine, methylene-blue, and gelatine, 1 to 2 grammes of copper sulphate be added, there is no effect of the action of the glycerine, the film being just as permanent as though none of the latter were present. Nickel and cobalt salts behave in a similar way. These observations, although of no direct practical value, show the enormous possibilities which exist as regards the adjustment of the sensitiveness of organic dyes, and should be of considerable interest as regards the theory of the bleach-out process.—A. von Hübl.

ARIDITY AND EVOLUTION.

THE EFFECT OF DRYNESS ON LIFE.

BY DR. D. T. MACDOUGAL OF THE CARNEGIE INSTITUTION.

Concluded from Supplement No. 1759, page 191.

GENERAL EFFECTS OF DESICCATION.

The consequences of a decrease of the supply of moisture in any region are very complex. If, for instance, the rainfall in Oregon, Indiana, Illinois, New York, or Florida were decreased gradually to one-third or one-fourth the average amount now received, the total production of organic matter would be greatly lessened, and consequently the amount of humus would decrease; wind erosion would remove much of this from its place of formation, and by this means alone the distribution of many species would be totally altered. The soil moisture would ultimately be so depleted that the surface layers would show as great a proportion as the underlying layers, and carrying an excess during seasons of precipitation, a fact that would have the profoundest influence upon the vegetation native to the region affected, determining not only the habit of the root-system, the form of the shoot, but also becoming a factor in distribution, and giving a new form to the competitive struggle among the organisms in a locality. The change in precipitation would result in the formation of long outwash, detrital slopes or bajadas, piedmont to the mountains, giving new habitat conditions, and a further differentiation would consist in the surface deposition of soil salts, giving alkaline and saline areas upon which halophytic forms might flourish. The lessened relative humidity would result in modification of foliar surfaces, make necessary special structures in seeds and spores, and would be followed by a more intense insolation by reason of the non-absorption of some portions of the spectrum; and lastly the course of the temperature of the soil would change with the depletion of the humus and the altered relations.

If desiccation ensued as a result of simple horizontal reduction of the precipitation, in a region with an unbroken surface lying at nearly the same height above the sea, the effect would be sweeping, monotonous, and with an almost total absence of selective effect that would mean extermination, or change in a flora *en bloc*. The majority of interpretations of the palæontological record assume such results. It is to be seen, however, that desiccation in a region with diversified topography and great difference in level would result in great differentiation; and if this reduction took the form of limiting the rainfall to one or two brief seasons or to limited periods, a maximum of effect might be expected.

The development of desert conditions in the manner described over a region of any extent would entail the least disturbance on mountain summits, where by reason of the lowered temperature and the facilities for condensation, the evaporating power of the air would remain lowest. The original or pre-desert forms would be able to maintain themselves on such elevated slopes with but little adjustment. Similar survivals might ensue along the lower drainage lines, where the underflow in streamways and washes might support a moisture-loving vegetation, as it does in southwestern Africa and southwestern America.

So much for survival by localization. A second manifestation would consist in restriction of seasonal activities. The rate of evaporation on the lower levels might be lessened by lower temperatures during the winter season, and at this time rapidly acting annual plants with broad leaves and trophophytic habit might develop from sprouting seeds and carry through their cycle of activity, remaining dormant in the form of heavily coated seeds during the warmer, drier period of the year. Perennials with deciduous leaves might display a coincident activity. This survival of moisture loving plants in a region of pronounced desert character is most marked, however, in places where the precipitation occurs within definite moist or rainy seasons, such as the great Sonoran desert, in which two maxima of precipitation occur separated by periods of extreme drought. Both the winter and summer rainy seasons are characterized by the luxuriant growth of broad-leaved annuals of a trophophytic habit, which might not be distinguished from those of any moist region. Some species are active during the summer season, and others during the winter, while a smaller number perfect seeds during both seasons. A number of perennials parallel this activity of the annuals, with the result that in the most arid parts of Arizona half of the native species are in no sense desert plants, requiring as much moisture for their development as do those of Maryland, Michigan, or Florida. The desiccation of a region is seen therefore not to result in the extermination of moisture-loving types, but rather to the reduction of their relative importance and a limitation of their activities to brief periods or moist seasons.

TWO TYPES OF VEGETATION RESULTING FROM DESERT CONDITIONS.

Two types of vegetation may be definitely connected with arid conditions, representing fairly distinct stages of development due to the influence of aridity. In one form the chief operation has been one of reduction and protection of surfaces. Leaves have been reduced to linear vestiges representing various parts of the foliar organ, branches to spines or short rudiments, stomata have special constructions, and all parts of the shoot are heavily coated and hardened; root-systems have been extended horizontally and the individuals thus isolated, being more or less accommodated to soils containing a large proportion of salts. The spinose, stubby, and switch-like perennials which result from such action are characteristic of low inclosed desert basins, like that of the Salton and those of Southern Africa and Central Asia, where the scanty rainfall does not occur within such regular limits as to make distinct moist seasons.

The second type of desert vegetation includes forms which have not only been modified in the manner described, but in addition have developed the storage function as a further step in the same direction. An increased capacity for rapid and effective absorption together with an enormous development of storage mechanisms in xerophytically modified stems, branches, leaves, or roots, has resulted in such groups as the cacti, the mesembryanthemums, the euphorbias, agaves, yuccas, sotols, crinums, crassulas, and others in which the individual often accumulates sufficient surplus water to meet its vegetative needs for a decade, while species are not unknown in which the supply on hand is sufficient to carry on the annual seasonal activity of shoot extension and reproduction for a quarter of a century. These forms are desert plants *par excellence*, showing two distinct stages of modification, the latter consequent upon the first. Marloth's view therefore, that the regions characterized by succulents, of which he names the Karroo of South Africa as an example, and which by implication would also apply to most of Arizona, Sonora, Chihuahua, and southern Mexico, are not true deserts, is directly controverted by the evidence obtained from a consideration of the evolutionary history of the constituents of the floras.

As a total result of the slow desiccation of any region, a very important proportion of the flora would consist of moisture-loving species, or trophophytes, and the remainder would be included in two classes, the spinose forms with reduced shoots and leaves and the succulents with shoots reduced but with the additional development of storage structure in some organ of the shoot or root. The total number of species within an arid region is not less than that of the most densely closed tropical area, but the number of individuals is less, the inter-relations of the individuals and species are widely different, and the competitive struggle for existence is of a nature widely different from that of a tropical forest. Increase in aridity tends to localization in distribution, and in humidity to diffuseness.

XEROPHYTES ARE OF RECENT ORIGIN.

Evidence of the existence of xerophytes in previous periods of desiccation is extremely scanty. Calamites and Lycopods with a slender central cylinder and a heavy inclosing cylinder of thin-walled tissue have been alluded to in this connection, but their great sporophytes probably stood in swamps, or at least were hygrophytic in habit, and by the requirements of their separated gametophytic reproduction could not exist on land areas independently. It is also to be noted that many forms peculiar to swampy areas at the present time display reduced shoots and leaves of a specialized structure due to the action of certain constituents in the substratum, that they are known as "swamp xerophytes," and if brought to light as fossils might give the impression of having lived in an arid climate. It is true, of course, that desert conditions are not favorable for fossilization, yet many opportunities for such action undoubtedly occur in the carrying and burying action of the torrential floods of desert streamways, while wind-blown deposits might preserve the more indurated forms. Many of these and the skeletons of the Cactaceæ would seem well adapted for preservation in this manner. The view that such forms are of recent origin, that is, since the Cretaceous period, within the present period of advancing desiccation, would predicate a very great phylogenetic activity, unprecedented perhaps, but by no means impossible. Among earlier types of plants capable of withstanding aridity most successfully, the cycads, bennetitales, and conifers may be included. Some of the forms included within these groups now inhabit desert areas, although others of similar structure with regard to foliage demand the greatest possible supply of moisture, so that the ascription of any casual relation between the leaf of a pine or cycad and desiccation must be made with many reservations.

The recession of large expanses of water included in a desiccating region, such as has occurred in the great basins in Nevada, and in the bolsons to the southward and eastward in New Mexico, Chihuahua, and Arizona, would present special conditions. The rate at which the waters of such inland seas might recede, however, would be such that the advance of vegetation to cover the emersed areas would be quite as rapid as that necessary to follow a receding ice sheet or a change of climate due to any cause. Thus our observations on the Salton show that beaches a mile in width may be bared within a year, while the agencies most concerned in their vegetation are combined wind action and flotation by the waters of the lake, together with the action of the small but torrential streams which occasionally rush down the shallow washes, carrying the heavier seeds and rocks with equal ease.

PROBABLE EFFECTS OF INCREASED HUMIDITY.

Many regions inclusive of the great central basin of Asia, the deserts of north and south Africa, southern Australia, and of the Americas, with a total area equal to one-sixth of the land surface of the world, offer the most diversified evidence as to the physiographic and vegetational effects of desiccation, which have been described, but when the attempt is made to consider the probable happenings consequent upon a reversal of the climatic swing, in which an arid region receives an increasing precipitation, conclusions must be drawn chiefly from experimental evidence derived from the laboratory.

Here, as in the decrease of the supply of water, no mass movement or extermination of a flora is to be taken for granted. Many highly specialized succulents, extremely local in their distribution, would undoubtedly quickly perish with the progression of a climate bringing in an excess of moisture; alterations in temperature would not exercise such violent action upon plants of wider range, however. That both together might not totally exterminate a type of succulent, is shown by the existence of cacti in tropical rain forests and on the high northern plains of Nevada, Idaho, and Montana. If plants of wider latitudinal distribution are taken into consideration, it may be seen that with an extension of polar climate, the extermination of a species in the higher part of its range would be coincident with additions to the eligible area on the southward. If the land area was limited, or if mountain barriers intervened, such dissemination would of

course be impracticable, and the forms involved would soon perish.

The unfavorable influence of increasing moisture upon the xerophytic forms of a region would also include effects of an indirect character. Soil temperature and moisture relations would undergo great alterations, humus would increase, and other changes would ensue, entailing conditions which the specialized structures would be unfitted to meet. Furthermore, succulents and spinose forms being advanced types, their retrogressive evolution to conform to moist conditions would be a process resulting in enormous loss of species. Some spinose types representing the lesser specialization would seem to offer the best morphological possibilities for such a change.

Perhaps the most important of all of the altered conditions brought about by increasing moisture, however, would be the total transformation of the competitive struggle for existence. Animals would no longer play the predominating rôle, as in arid areas. The number of individuals representing the constituent species of a flora would be multiplied a hundred fold, perhaps a thousand fold, and once more the amount of food material offered to animals would decrease their total importance in selection, while the intensest crowding between roots and between shoots would once more be resumed, and horizontal differentiations of associations, such as that in forests, would ensue.

The element of the flora which would respond most readily to ameliorated aridity would, of course, be the hygrophytic annuals and perennials, which had survived the period of desiccation in their refuge of the rainy seasons, and in the moist areas along streamways and on elevated peaks. These would quickly occupy the greater part of the surfaces available for plants, to the great intensification of the intervegetal struggle for existence. As these hygrophytes survived in the moist situation and the moist seasons of an arid period, so the surviving xerophytes in a moist period would find refuge in restricted habitats on talus slopes, rocks, and sand in which the soil-structure relations would be best suited to their specialized structure, and might display their seasonal activity during a period of the year in which the precipitation was least.

GENERAL CONCLUSIONS.

In a brief summarization of the main features of the subject, it is to be recalled that free water was a very important agent in the origination of self-generating matter, and that the development of the vegetal organism up through the gametophytic stage was accomplished in its presence.

It was in the stress of aridity encountered in extended and elevated land areas, however, that the development of the sporophyte, with its highly differentiated vascular system, complicated physiological organization, and seed-forming habit occurred.

Certain geological formations laid down at a time when the prevailing types of vegetation were characterized by separate gametophytes are devoid of fossils. Fossil xerophytes are unknown, although fair evidence of aridity in the Cretaceous and earlier is at hand. Certain groups of plants, however, including the cycads, bennetitales, and conifers, show structures which would be suitable for existence under arid conditions, although not all of the forms so equipped inhabit arid areas.

Rock formations indicate the prevalence of arid conditions over extensive areas as far back as the records may be interpreted. The desiccated regions coincide only in part with deserts of the present time. Desert conditions appear to have prevailed in central Asia, north and south Africa, western and eastern South America (?), parts of Australia (?), and southwestern America, since Cretaceous times. In the Lop basin of Asia, the central valley of Arabia, portions of the Sahara, the Kalahari in southern Africa, the Lake Eyre basin in southern Australia, the Salton basin in California, and the elevated basins of Nevada and Utah, the characteristic vegetation is composed largely of spinose and switch-like forms, in which the chief development has been toward restriction and induration of surfaces; a result attributable to the degree of aridity, the seasonal distribution of the rainfall, and also to the intervention of great climatic oscillations.

The Karroo in South Africa, the Brazilian and Chilian deserts in South America, the Sonoran and Chihuahua deserts, and pre-eminently the arid areas of southern Mexico, offer a wide variety of types of vegetation in which the evolutionary development has been carried much farther, with the acquisition of exaggerated storage functions, representing the extremest and latest stage of differentiation of the sporophyte in its long encounter with arid conditions on land areas.

At the new steel works at Gary, Ind., the gases from sixteen blast furnaces, each of which has a capacity of 450 tons a day, will be utilized for the generation of electric power. Gas engines have been worked successfully in this manner in steel works at South Chicago.

Correspondence.

ADDING BY 3'S AND 9'S AND NON-CARRYING MULTIPLICATION.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

It might be supposed from the many calculating machines now on the market that it would be useless to set forth another process of mental addition. But we must not forget that typewriters have been in use for a much longer period, and are more fully developed and much cheaper. Yet a great deal of writing is still done with the pen. Although calculating machines are of great use in large offices, yet many persons still have, and will have, to depend upon mental instead of machine computation.

Many have long columns to add. This is a very laborious work, as many a bookkeeper, statistician, and civil engineer can testify. Often under the pressure of work men become very weary, slow, and inaccurate. Here is a method of adding by 3's that may be of use to such.

RULE.

Write the numbers to be added in columns as usual, and beneath them draw two parallel lines. Pass the pencil up the right-hand column, letting it touch every 3, 4, or 5 in the center, every 6, 7, or 8 at the bottom and at the top, and every 9 at the bottom, in the center and also at the top. Add three every time the pencil touches, saying 3, 6, 9, 12, 15, etc.

Then pass down the column, letting the pencil touch every 1, 4, or 7 at the bottom, and every 2, 5, or 8 at the top and also at the bottom. Add one every time the pencil touches on the downward trip, saying, for instance, 16, 17, 18, etc. The result will be the sum of the column.

Write the units in the proper place below the parallel lines, and put the tens between the lines, so that they will stand under the next column.

Then proceed likewise with each of the remaining columns, treating the number carried to the column as a part of the column, and subject to the same process. When the left-hand column is added set the whole result below the parallel lines.

		9	36 33 30	
34		18	27 24	37 38
35		17	21 18	39
36 37	33	56	15 12	
38	30	45	9	40 41
	27 24	64	6	42
39	21 18	73	3	
	15 12	62		43 44
40	9 6	71		45
41 42		20		
43	3	4		
		435		

REMARKS.

A study of the example will make the process clear. The inner columns of small figures are the upward counts, and the outer columns the downward ones. Of course the calculator would not write down the counts. They are simply put here to make the operation easily understood. The reason of the rules is obvious. The figures are partitioned, as it were, so that the digits can be added by easy steps.

A SHORTENING OF THE PROCESS.

At first the calculator should always touch the same figures at the same points, and these points always in the same order, so that they will soon become so thoroughly fixed in the mind that there will be no hesitation and no mistakes.

		9	36	
		18	27	
		17	18	39
36	33	56		
	30	45	9	
	27	64		42
39	18	73		
		62		
	9	71		45
42		20		
43		4		
		435		

After that the calculator can shorten his work by touching only every third point to be counted in passing up the column, and thinking 9, 18, 27, etc., until he nears the top of the column. Then he may have to add three for each of the remaining upward points as 30 and 33 in the second column of the example.

Then in passing down the column he can touch every third point to be counted, and then add three each time, until he nears the bottom, when he may have to add one for each of the remaining points, as in the count of 43 in the second column.

This shortening of the process after the calculator becomes familiar with the points to be counted will save much time and labor.

NON-CARRYING MULTIPLICATION.

There are many persons of considerable attainments who find arithmetical work so hard and repulsive that they would be glad to write twice as many figures, if they could by such means lessen the mathematical steepness. Such persons may find the non-carrying multiplication of use, because a great part of the burden in multiplying is the carrying part, and the non-carrying method leaves all the addition to be done by the easy steps of 3's and 9's.

PROCESS.

In multiplying 9,547 by 8, each individual product might be set down in a line by itself, as shown in the first example below, and then added. But this would take up too much space. So the individual products can be written alternately in two lines, as shown in the next example.

Two lines should be used in the product for each digit of the multiplier, except when the digit is 1, and then only one line should be used.

Each individual product in the double lines should occupy two places. In case there is only one figure, the vacant place should be filled with a 0, as before the final 8 in the line 1808 in the examples.

The non-carrying multiplication may be performed more quickly by beginning the multiplication at the left, as in the third example, instead of at the right. But the addition must be performed from the right toward the left.

EXAMPLES.

9547	9547	9547
8	128	128
56	4056	9547
32	7232	1808
40	1014	1014
72	1808	7232
	9547	4056
	2111	2111
	9814316	9814316

THE BENEFIT.

These processes will not be of use to the expert accountant, who can read off the sum of any two digits at sight or even at the thought of them, and who takes pure delight in cross multiplication, because it saves the manual labor of making figures. But they may be of great service to many a second- or third-rate calculator who may know a great deal more in other directions than the skillful mathematician does, and yet find arithmetical computation a serious drag on his scientific work. Such can soon gain the necessary practice, so as to add long columns and multiply large numbers easily, accurately and even quickly. A few minutes' careful practice each day for several weeks will work wonders in this direction. So much for adding by series.

New York. G. W. WISHARD.

PAINT FOR IRON SHIPS.

IN order to protect iron vessels from the action of sea water and marine organisms, Holzapfel, in 1895, devised the method of painting the hull, first with ordinary paint, to prevent rust, and, secondly, with a mixture containing bichloride of mercury, for the purpose of destroying injurious organisms. One formula contains the following ingredients: Sulphate of copper, 40 parts by weight; oxide of iron, 13.8 parts; oxide of lead, 1.5 part; bichloride of mercury, 9 parts. One application protects the hull for six months.

A Geneva firm has recently devised a protective mixture in which the bichloride of mercury is replaced by an amalgam of copper, containing a large proportion of copper, the formula being: Copper amalgam, 6 parts; red ocher, 7 parts; waterproof varnish, 24 parts. The protection lasts for twelve to eighteen months. The varnish perfectly resists the action of sea water, but begins to disintegrate when barnacles and seaweed attach themselves to it. The result is that particles of the amalgam are exposed to the action of the sea water, and cuprous chloride and bichloride of mercury are produced. The two chlorides combine to form a double salt, which is exceedingly poisonous to the invading organisms. The action is purely local, and the coating remains intact except where it is attached by algæ or molluscs. The poison is produced only when and where it is needed. The importance of protecting the hulls of vessels is shown by the following examples: An Austrian vessel, having a length of 310 feet and a submerged surface of 15,000 square feet, accumulated more than 4 tons of seaweed in the Indian Ocean. An American warship had a similar experience in the bay of Rio. The speed of the vessel was diminished by 2.3 knots, and 1,000 tons more coal were consumed on the return than on the outgoing voyage.

ENGINEERING NOTES.

Experiments on the effect of potash fertilizers on the quality of the wine produced by the vineyards so fertilized have been made in Liebfrauenthal in Hesse. Comparisons were made between wines of the same kind produced with and without the application of potash salts. White wines were found to be little or not at all affected by potash applied to the soil, but the quality of red wines was distinctly altered.

The Engineering Record states that bonding new and old concrete can be accomplished in the following manner: Clean the surface of the old concrete with clear water and a stiff broom. Apply a mixture of one part of hydrochloric acid and three parts of water with a brush, making several applications one after the other. Then scrub the surface with clean water and a stiff brush until all the acid is washed away and the surface is perfectly clean and free from loose particles. While it is still wet apply the fresh concrete, and keep the new concrete damp for at least a week, being careful not to allow it to become dry at any time.

The high-pressure pumping station on Delaware Avenue, Philadelphia, has proved so successful that it will be practically duplicated at Seventh and Lehigh Avenues, in the city's mill district. It will contain ten 300-horse-power vertical single-acting gas engines, direct connected to triplex pumps, and a 140-horse-power unit for auxiliary purposes. Fuel gas will be drawn from the street mains, and two large holders in different parts of the city will furnish the supply. Experience with the present plant indicates that any unit can be made ready to pump against 300 pounds pressure in 45 to 60 seconds from the time the signal is received, and the whole station can be put in operation in seven to ten minutes.

It is reported that the Swedish Riksdag has asked for renewed experiments to be undertaken in order to investigate the question of coal and peat used as fuel on railways, and new trials are now to be made. Between Elmhult and Alfvesta there will be run a special train, consisting of fifty wagons, loaded with coal and peat. This train will be running for a fortnight between the two places, using alternately as fuel English steam coal, peat, and steam coal in different proportions, and peat only. There will also be used different types of locomotives. The results of the experiments are looked forward to with great interest, especially by those who are connected with the peat industry.

The Engineering and Mining Journal states that pipe-line connections have been completed by which it is possible to pipe oil from the Oklahoma wells to New York harbor. This is the longest pipe-line in existence in the United States, and, indeed, in the world. It is not probable that much oil from the mid-continent district will be brought to the seaboard at present, and the completion of the line seems to be more in the nature of a provision for the future or for emergencies which may arise. Oklahoma has the most active oil field in the country at present; moreover, its production is increasing, while that of Pennsylvania and West Virginia is decreasing. It may not be long before the western wells will be called upon to supply the seaboard and export demand.

A remarkable outrush of carbon dioxide occurred in 1907 in a French coal mine, in which smaller disengagements have been common for many years. During the deepening of the shaft in question, a first violent disengagement of gas occurred in November, 1906, and a second and still more violent one in July, 1907. On the previous day the shaft had arrived at a depth of about 1,000 feet, and reached a coal seam which extended over its entire section. In this seam, five blasts, aggregating three pounds of dynamite, were exploded. There was no immediate disengagement of gas. During the night eight blasts, aggregating five pounds, were placed in position, and were set off at 4 o'clock in the morning. This time there was an instantaneous and very violent discharge of carbon dioxide. Three workmen were suffocated, and a great column of coal dust rose in the air to a height of more than 100 feet. At the same time, dust and carbon dioxide were discharged in large quantities by a second shaft and the ventilating shaft. The discharge of dust continued for an hour and a half. In the machine room, sixty feet from the mouth of the shaft, a layer of dust a yard deep was formed. Symptoms of asphyxia were experienced by many of the occupants of neighboring houses, and throughout the surrounding country, within an area about 3,300 feet long and 1,600 feet wide, chickens, dogs, and birds were killed by the outflow of gas, which continued for twelve hours. 523 tons of very fine coal dust were collected from the surface of the ground, and it was estimated that an equal quantity was carried off by the wind. A gallery communicating with the shaft at the depth of 650 feet was entirely choked with the dust, which penetrated to workings 500 feet from the shaft. Nearly 1,800 tons of coal dust were taken from the various galleries in the mines. The coal seam pierced by the shaft was about 60 feet thick. The great violence of this disengagement of gas may be attributed to two causes—the unusual thickness of the seam and the large area over which it was simultaneously attacked.

SCIENCE NOTES.

A good example of the economy often accomplished by chemical investigation and discovery is furnished in the case of ultramarine. Many years ago when this was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Now that the chemist has discovered how to make the same material for such cheap substances as kaolin, sodium sulphate and carbonate, charcoal, sulphur, and rosin, the price is only a few pence per pound.

Cheaper radium is promised by the discovery that the ash of lignite found in Sweden contains radium which can be extracted by an inexpensive process devised by Dr. Gustaf Hellsing. A company has been formed for exploiting the invention. Acccording to Engineering it is expected to extract about 0.075 grain Troy from each ton of the raw material. The technical side of the problem is fully solved and there is no doubt as to where and how the radium can be obtained, but there is, of course, the risk that the present enormously high price of radium may be reduced through fresh discoveries.

Mineral oil companies and iron manufacturers who use the recovery process, states the Chemical Trades Journal, will be interested to learn that India is likely to become a considerable consumer of sulphate of ammonia. This is in connection with the cultivation of the sugar cane, which is being encouraged in the Bombay Presidency, where experiments for the improvement of the cultivation are in progress. The use of sulphate of ammonia as a fertilizer on cane fields has been established in the West Indies and in Japan. A statement is made that sulphate of ammonia is likely ere long to be manufactured on a considerable scale in India itself.

A Paris correspondent of the Times states that a law has just been promulgated in the Journal Officiel prohibiting the use of white lead. The terrible ravages caused by plumbism in the manufactories of this article and among painters and other workpeople who use it have for a long time excited public notice. The question has been debated at great length in parliament for upward of five years, owing to the defensive measures adopted by manufacturers engaged in the white lead industry. The present law enacts that, after the expiration of five years, the use of white lead, or of paint composed of linseed oil and white lead, and of all special compounds containing white lead in any form, shall be prohibited for every description of painting work.

The presence of acetic aldehyde in wines is found by A. Trillat, of Paris. In his recent researches he shows that the aldehyde exists in wines and brandy in the proportion of 200 milligrammes per liter (1 in 5,000) at a maximum. It appears to be due to oxidation by the air, and he finds that aerating, agitation, and the presence of micro-organisms will increase the proportion of aldehyde. This body, however, tends to disappear with time, and it either precipitates the coloring matter or enters into combination with the alcohols and thus forms acetals. It may also be transformed to acetic acid and then to ether so that it contributes to the flavor of the wine or "bouquet" which is acquired by old wines. The aldehyde and acetals can also be transformed into resins and in this case they have the effect of yellowing old wines and brandy.

The beginning of the past summer was marked in France and Belgium by great cloudiness and a mean temperature lower than the normal. But the summer of 1909 was not exceptional in this respect, for still colder Junes were experienced in 1841, 1843, 1869, 1871, 1882, and 1884. A cold period in early summer is always accompanied by the presence of an anti-cyclonic condition of high barometric pressure on or near the west coast of Europe, while low pressures prevail over the rest of the continent. These conditions produce cold northerly winds and great cloudiness. The length of the cold period which results naturally depends upon the duration of the atmospheric condition which causes it. The causes which produce, maintain, and destroy this condition are unknown. A cold June does not furnish any reliable indication of the temperature of the rest of the summer. Cold summers are often cited as evidence that the climate is gradually becoming colder, but this opinion is erroneous. Cold summers and hot summers will occur in the future as they have occurred in the past. The summer of the year 820 was so cold and wet that the crops were almost destroyed. The same conditions caused famines in 1033 and 1044. Among other cold summers those of 1151, 1219, 1315, 1423, 1512, 1596, 1639, 1644, 1667, 1709, 1710, 1740, 1756, 1770, 1796, 1799, 1809, 1812, 1813, and 1816 were especially remarkable. In 1512 several persons were accused of having caused the inclemency of the season by sorcery, and were burned at the stake.

TRADE NOTES AND FORMULÆ.

Bead essence, according to Geissler, is a preparation that produces a fine bead on brandy, which property increases its value. If to the brandy we add a little ammonia soap made from oleic acid—not oil—and ammonia, it will form a fine bead on being poured out. Bead essence, according to this, in all probability a strong, alcoholic ammonia soap solution, is in large demand in some places.

The blackening of brass can be effected by dipping the metal in the following solution and then heating it over a Bunsen burner, or an alcohol flame. The dipping and heating are repeated until the brass is darkened, then it is brushed and dipped in negative or matt varnish. The solution is prepared by adding to a saturated blue vitriol solution a saturated solution of carbonate of ammonia, until the precipitate, at first thrown down, is completely dissolved.

Varnish for locksmiths' work is prepared by heating, in an iron pan, 30 parts of West Indian copal, 5 parts each of natural asphalt, American pine rosin, and coal-tar pitch and 1 part each of Venice turpentine and wax. The molten mass must be stirred until it flows smoothly off the spatula. Then add at once 6 parts of oil of turpentine, 2 parts each of linseed oil varnish and rosin oil, and allow the mass to cool. Finally, the mixture is diluted with petroleum benzine, until it flows readily from the brush.

Moth Tincture.—To keep moths out of furs and clothes take 125 parts alcohol and as much spirits of turpentine and dissolve in the mixture 30 parts of camphor. This mixture is kept in a bottle and should be well shaken before use. The furs are folded in linen and in the drawers or chests, in which they are to be kept, lay blotting paper, moistened with the fluid. In the closets in which clothes hang, balls of such paper may be placed. The powerful odor drives away all insects, even kills them. When exposed to the air, however, it soon leaves the clothing. The process must be repeated annually and has proved very effective.

Bronze Colors from Metallic Oxides.—According to the following methods, beautiful colored bronzes can be produced from metallic oxides and solution: White Bronzes: Sulphate of zinc, chemically pure and free from iron, is heated to redness in a clay retort for some time. Light Bronze: 1,000 parts of concentrate solution of sulphate of zinc, is mixed with 30 parts of nitrate of cobalt solution, 30 parts of nitrate of nickel solution and 10 to 15 parts of nitrate of copper, all registering 15 deg. to 16 deg. Bé., the solution is then evaporated down and heated to redness. The color darkens if the heating is protracted. Bright Pink Color: Mix 1,000 parts of sulphate of zinc solution with 30 parts of nitrate of iron solution of 20 deg. to 25 deg. Bé., evaporate and heat to redness. An addition of 40 parts of iron solution changes the color to a dark pink. Leather Yellow: 1,000 parts of sulphate of zinc solution and 12 to 30 parts of green vitriol solution, of 28 deg. to 30 deg. Bé., treated as described in the foregoing recipe; in the same manner make golden yellow from 1,000 parts sulphate of zinc solution and 28 parts nitrate of manganese solution of 12 deg. to 14 deg. Bé. A variety of shades may be produced, according to whether the heating to redness, after evaporation, is more or less protracted. Yellow green is obtained from 1,000 parts of sulphate of zinc solution and 25 parts of nitrate of nickel solution of 15 deg. to 16 deg. Bé., with a small addition of nitrate of silver solution. Green Cinnabar: Dissolve 90 parts of green vitriol and filter the solution, after which it is mixed with a filtered solution of 120 parts of prussiate of potash, whereby a bluish green precipitate is formed. To this a concentrated solution of 400 parts of alum is added, while stirring, also 100 parts of finely washed chalk, and when the effervescence this causes has subsided, 900 parts of sugar of lead, after which the deposit is washed out, dried in a gentle heat and finely ground. These pulverized colors can be used, mixed with a little bronzing oil, for bronzing; if on the other hand they are well rubbed down with varnish they may be used as covering colors, which, in contradistinction to glaze colors, do not permit the ground color of the object to show through.

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